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PART OF THE COFFER DAM AT THE ENTRANCE to the new dry-dock now under construction at the Charlestown (Boston) Navy Yard failed on April 17. This coffer-dam, which had never been pumped out, consists of two walls about 20 ft. apart, between which is a clay filling. Each of the walls is composed of two layers; first a bulkhead built up in place of 4×6 in. timbers laid flat and spiked together, outside of which is a row of 6-in. grooved and splined sheet-piling. There is one waling timber, a little above low water level, and the ties are 1-in. round iron; 4×6 in. braces were placed at three or four levels, but since the failure 8×8-in. braces are being used. The longest piles are about 52 ft. in length, and all are driven 5 or 6 ft. into hard pan, passing through a varying thickness of dock mud. It is supposed that two of the ties gave way first, as about ten feet of the outer wall moved outward at the bottom. As the clay filling, not all of which had been placed, was a practically fluid mass, a flowage of this material followed, and about 200 ft. of the coffer-dam gave way. The total length of the coffer-dam is probably about 800 or 900 ft. The wreck is now being removed, preparatory to rebuilding. The contractors for the dry-dock, who are doing this work, are Messrs. O'Brien & Sheehan, of New York. Although the coffer-dam has not been purposed out, about 110,000 cu. yds. of material have been excavated by dredging, leaving only about 60,000 cu. yds. to complete the required amount.

AN ELECTRIC POWER PLANT, developing 600,000 HP., is being promoted, involving the utilization of a fall of 300 ft. in the Kaministiqua River, near Port Arthur and Port Williams, Canada. A canal 15 miles long would have to be built, and the company is capitalized at $5,000,000. The chief promoter is D. S. Wegg, President of the Railway Supply Co., of Chicago, Ill., and a company has been incorporated at Toronto.

THE MERIDA ELECTRIC LIGHT CONTRACT, the first granted in Yucatan, has been secured by the Siemens-Halske Co., of Germany, for $500,000. The American bidders failed because the foreign firm offered better prices, better delivery and better conditions; and the latter went to much more trouble and expense in going into exhaustive details and ascertaining just what it could do. A $300,000 iron pier contract, at Progreso, went to an English company for similar reasons; and German and Belgian manufacturers have supplied about $1,000,000 worth of portable 8 lb. rails, for which there is a large demand in Yucatan. One American firm is now competing sharply for this latter business.

THE LEASE OF THE THIRD AVENUE RAILWAY, of New York, to the Metropolitan Street Railway Co. for 999 years, was ratified last week at a stockholders' meeting, and the capital of the latter road was increased from $45,000,000 to $52,000,000 to meet this obligation. President Vreeland told the stockholders that the Metropolitan Co. in 1894 controlled 131 miles of operated track, with $5,398,405 gross earnings, and operating charges of 60% and fixed charges of 34%. It now operates 224 miles of track, earned last year, in gross, $13,525,524, and its operating charges had been decreased to 46.7%. While its track had only increased from 131 to 224 miles, its car mileage had increased from 17,383,500 to 41,760,856. He expected greater results in the near future as an outcome of consolidation and general business growth.

THE POLK ST. VIADUCT is the latest addition to the Chicago bridges which are too dangerous for traffic. An examination has shown that the floor system is corroded by rust to a dangerous degree, and the viaduct has been closed to traffic. The Commissioner of Public Works claims that there are no funds available for repairs, and that the structure should be repaired by the Chicago Terminal Transfer Ry. Co., which company, however, declined to undertake the work.

THE NICARAGUA CANAL BILL is defeated by a vote of 21 to 28, on a motion in the U. S. Senate to take up the bill. The Administration desires to postpone action until next session, when the reports of the Isthmian Canal Commission will be in.

AN AUTOMOBILE HIGHWAY SYSTEM, about 500 miles long and to cost about $3,000,000, is being discussed among property-holders in the scenic section of New Hampshire. The road would start from Boston and pass through Lexington, Concord, Dublin, N. H., and on to Keene. From Keene it would cross to Lake Sunapee; then branch to the Corbin deer-park; pass to Springfield and Hanover, to the Connecticut lakes; through the White Mountains to Plymouth, and down to the Maine coast and back to Boston along the sea coast. President Chamberlain, of the Automobile Association of America, is said to be deeply interested, and proposes connections through the Berkshires. The roads would be macadam, and it is estimated that they could be constructed in five years. Toll stations may be established, and all but pleasure vehicles excluded from them. In the latter point will come the opposition and difficulty.

THE NEW BAKU-BATUM OIL-PIPE LINE, ultimately to be 560 miles long, has been completed for 145 miles, covering the first section, says U. S. Consul Thomas Smith, of Moscow. This 8 in. wrought-iron pipe is to parallel the Trans-Caucasian Railway, and the new line is being laid by the engineers of that road. This first section has three pumping stations, each station being equipped with two Worthington compound high-duty engines, with 21 and 42 in. steam cylinders with 24 in. stroke. These pumps work against a pressure of 650 lbs. to the square inch, with a steam pressure of 150 lbs., and the duty of each pump is fixed at 416,275,200 gallons of oil pumped per year.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Dubois, Ill., on May 17. The boiler of the locomotive pulling the south-bound limited on the Illinois Central R. R. exploded as the train was slowing up for the station. Five men were killed.

THE PROPOSED HARBOR AT TOKYO, JAPAN, says Dr. Turnichi, Vice-Minister of Communications, will cost about $30,000,000, divided as follows: Stone-faced embankment and quays, $7,000,000; reclamation, $4,500,000; machinery, $2,500,000; materials and sundries, $6,500,000; warehouses and buildings, $9,000,000. The payment of this total sum would be spread over about ten years, at the rate of $1,500,000 the first year and $2,500,000 for each year thereafter until finished. Another harbor is proposed at Kobe, to cost $11,500,000. This scheme includes the reclamation of about 300 acres of foreshore, a harbor depth of 24 to 30 ft. and a breakwater to inclose an area of 560 acres having a depth of 30 ft. and more. The harbors of Osaka, Matsushima, Itozaki, Takamatsu, Otaru and Abashiri are also to be improved at a cost of from $2,700,000 to $4,200,000 each. This large amount of harbor work should result in a lively demand for suitable machinery.

EXPORTS TO ASIA AND OCEANIA in the fiscal year ending in June, 1900, will exceed $100,000,000 in value, for the first time in our history, says the U. S. Bureau of Statistics. In 1893 this total was only $27,421,831. More than half the sugar now imported into the United States comes from the East Indies and the Hawaiian Islands. The growth in exports to Asia and Oceania is chiefly in cotton, breadstuffs, provisions and manufactures. In the nine months ending March, 1900, the value of all exports to these regions was $82,667,398. Of this aggregate Japan took material to the value of $23,339,738; Australasia, $19,991,170; China, $12,495,583, and the Hawaiian Islands, $10,214,136.

ELECTRIC OMNIBUSES are proposed in Chicago by a company called the Hub Motor Transit Co. The motors are to be applied directly to the hubs of the wheels, and there will be one motor to each wheel.

ICE MACHINERY IN CENTRAL AND SOUTH America is reported upon fully in a volume just issued by the U. S. Bureau of Foreign Commerce. This report gives a list of the owners of existing plants, as compiled from consular reports. The possibilities of further extension of the trade and the sale of ice-machines is fully discussed.

THE CUBAN CENSUS, taken under the direction of the U. S. War Department, shows a population of 1,572,795. The Spanish census of 1887, the last taken under Spanish rule, called for 1,631,687 inhabitants. The area of Cuba is 44,000 sq. miles, and the average density of population is thus 35.7 persons per sq. mile, or about the same as for the State of Iowa.

THE GERMAN COLONIES IN AFRICA, says the "Bullettino delle Finanze," of Rome, have an area of about 907,355 sq. miles. In these colonies there are no navigable waterways, and only 93 miles of railway. The German Colonial Department has been trying in vain to obtain from the German Parliament a decree for the construction of a railway across German Oriental Africa, and to connect Lake Tanganika with the Pacific. This colony now has only 26 miles of railway, extending from Tonga to Muhesa; the line is one metre gage, and was built in 1891 by a German company to reach the rich plantations of Usambara. In 1899 the Reichstag purchased the line, and proposes to continue the road to Korogwe. A central line of 93 miles is projected from Dar es Salam to Tabora, following the caravan route; and from the latter point a branch would reach Lake Victoria Nyanza. A second branch would follow the coast from Salam to Bogamoyo. In German South Africa there is 74 miles of railway, connecting the port of Swakopmund with Windhoek; it is only operated for 60 miles—to Jakalswater. The gage is 23 ins. In Togaland a narrow-gage will soon be constructed, from Lome to Petit-Popo. We are indebted for the above notes to the press correspondents department of the Philadelphia Commercial Museum.

WATERPROOF MATERIAL IN GERMANY is reported upon by U. S. Consul E. T. Liefeld, of Freiburg. At that place a firm makes use of a solution containing zinc, copper and ammonia hydrate, for waterproofing goods, and has patented its process in many countries. The copper in the solution gives a beautiful blue-green without the use of other dyestuffs; there is no clogging of the fabric; the weight remains almost the same, and as there is a chemical compound between the fibre of the fabric and the solution, the new properties are firmly fixed. The copper also is claimed to prevent the growth of destructive germs; goods have been unaffected by being buried for a long time, though the same goods untreated showed signs of decay. There is no fatty substance in the solution, and the fabric is not liable to attack by insects or worms. The German army is making free use of the new cloth for tenting, horse-blankets, etc., especially in tropical regions. The goods are not only light and waterproof, but they are odorless, do not break or become sticky, and do not prevent the free circulation of air.

LARGE DEPOSITS OF IRON ORE IN SWITZERLAND are included in a concession recently granted to Mr. Mueller-Landsmann, of Zurich Enge. These deposits in the Bernese Oberland have been known since the 14th century, and they were worked until about 1798. Investigation by geologists show that the deposit extends from Urbachthal to the Canton of Unterwalden, almost ten miles; the seams vary from 13½ to 33 ft. in thickness. Recent analyses by Prof. Tetmajer, of the University of Zurich, show an average of 50% of iron, and a report by Prof. A. Heiss estimates that there are 14,276,000 tons of ore in one comparatively small bed. While the beds lie at a small depth below the surface and shafts are not necessary, the mines are 7,000 ft. above the sea, and work is impossible in winter. The mines can be worked for nine months, and they will soon be connected by a railway with the Brunig Railway. Water power is abundant, and it is said that the smelting will be done either by electric furnaces or by calcium carbide manufactured on the spot. Both methods have been tried with satisfactory results.

THE BANANA PLANT, says J. de Loverdo, in "El Progresa de Mexico," will feed 150 men from the product of one hectare of land so planted; while the same area in wheat would only supply food for 6 individuals. For the same space and under similar conditions of cultivation its production is 40 times that of potatoes and 100 times that of wheat. The fruit of the banana contains 72% of water, 2.14% of nitrogenous matter and 22% of saccharine substances, the latter giving it its great nutritive quality.

SANDSTONE BRICK, an invention of Wilhelm Schwarz, a chemist of Zurich, is referred to by U. S. Consul B. H. Warner, of Leipsig, Germany. He does not go into the details of manufacture further than to say that he mixes dry sand with lime in a vacuum to avoid aeration of the lime by the carbonic acid of the atmosphere. At the same time the temperature is raised and kept at a certain degree by steam heat, and then moisture in the form of steam is admitted. The action of the steam causes the condensation of the silicic acid in the sand and lime, and provides the proper proportion of cementing particles in the mixture. A special machine is employed in the manufacture. The resulting brick is extremely hard, waterproof and impervious to frost and unaffected by all acids.

EIGHT-TRACK ROLLING-LIFT DRAWBRIDGE OVER THE CHICAGO DRAINAGE CANAL.

The Chicago Drainage Canal was intended from the first to form a link in a navigable waterway between the Great Lakes and the Mississippi River, as noted in our issue of May 3, and for this reason it was necessary that all bridges crossing the canal should have draw spans to provide for future navigation. Practically all of these bridges so far built have swing spans, the general features of which were described and illustrated in our issue of Dec. 2, 1897, and it was then explained that in view of the fact that the canal would not be used for navigation for some years, material economy had been effected by omitting the operating machinery until such time as it becomes necessary to open the canal for navigation.

FIG. 2.—SITE OF EIGHT-TRACK DRAWBRIDGE FOR THE CHICAGO DRAINAGE CANAL.

(View on Date of Commencing Work, May 23, 1899.)

The largest and most important of these Drainage Canal bridges, however, will be of the Scherzer rolling-lift bascule type, and will be located just west of Campbell Ave., in the city of Chicago. At this point the line of the canal is crossed by three railways with eight parallel tracks, all close together. The Pittsburg, Cincinnati, Chicago & St. Louis Ry. owns four tracks; the Chicago Terminal Transfer Ry. has two, and the Chicago Junction Ry. also has two. During the construction of the canal, the full width of the channel was not excavated at this point, but a narrow channel was cut for the use of the tugs and scows used in handling the excavated material, etc. This was spanned by fixed plate girder bridges of 80-ft. span. As a result of the negotiations between the railway companies and the Trustees of the Drainage Board in regard to the drawbridge, the Board agreed to build and pay for a bridge of a design to be approved by the railways, and also agreed to pay to the railways a sum of money of which the interest would suffice to pay the expenses of maintenance and operation.

When proceedings had reached this stage, the type of bridge to be adopted had to be determined. No eight-track drawbridge had ever been built, and the widest railway drawbridge then existing was the four-track swing bridge carrying the New York Central R. R. over the Harlem River. This bridge has a span of 389 ft., a width of 61 ft., and a weight of about 2,500 tons. It was described and illustrated in our issues of June 15 and Aug. 31, 1893, and April 30, 1896. After a careful study of the situation, plans for a center-pivot eight-track swing bridge were prepared by Mr. W. M. Hughes, M. Am. Soc. C. E., Consulting Engineer of Bridges of the Drainage Board, under the direction of Mr. Isham Randolph, Chief Engineer. This bridge was to be 399 ft. 2⅝ ins. long and 116 ft. wide, with four main trusses 29 ft. 6 ins. apart, c. to c., and extended floor beams carrying a single track outside of each outer truss. The turntable drum was to be 78 ft. 7 ins. diameter. Bids were asked for the construction of this bridge, and at the same time competitive designs were also invited, with the result that three designs were submitted by the Scherzer Rolling-Lift Bridge Co., Mr. C. L. Strobel, M. Am. Soc. C. E., and Mr. Onward Bates, M. Am. Soc. C. E. (represented by the Edge Moor Bridge Works). These designs were briefly described in our issue of April 7, 1898. They were rejected by the Board, which adopted Mr. Hughes' design for the swing bridge, and awarded contracts for the construction of the substructure and superstructure.

The railway companies, however, declined to approve of this design, mainly on two grounds: (1) With all the tracks on one structure traffic would be completely blocked in the event of any disablement of the bridge or its machinery (as this would necessitate its being kept open for navigation until repairs were made) or in case of any obstruction in the channel which might prevent its being closed; (2) the center pier and protection pier would leave two comparatively narrow channels, through which vessels would have to pass slowly and carefully, thus increasing the delay to the railway traffic. As the railways absolutely refused to change their positi[on] in this respect, the Drainage Board had to al[ter] on the design, and new designs and bids wer[e] in[-] vited. No less than seven designs [were] sub-mitted, as follows: (1) C. L. Strobe[l], M. Am. Soc. C. E.; (2) M. G. Schinke (represent[ing] by the Milwaukee Bridge & Iron Works); (3) [Scherzer] Rolling-Lift Bridge Co.; (4) Onward Ba[tes], M. Am. Soc. C. E. (represented by the Edge M[oor] Bridge Works); (5) J. A. L. Waddell, M. Am. [Soc.] C. E. (represented by the King Bridge Co.); (6) [Hen.] H. Breithaupt, M. Am. Soc. C. E.; and (7) [Wil-]mann and M. Franzen. The details of [the] con-troversies over the designs will be found [in] our issues of April 7, Aug. 25, Oct. 20, and [Nov.] 10, 1898. After some considerable delay due to liti-gation, the contract was finally awarded [on] Aug. 10, 1898, to the Scherzer Rolling-Lift Bridge Co. of Chicago, for the construction of both substruc-ture and superstructure. Under this contract, the bridge is to be built as a fixed structure, the company to act as supervising engineer of the present work and also of the future work of erecting the additional parts, operating machinery, etc., required to complete it as a drawbridge.

The design of the bridge is shown by the plan and elevation in Fig. 1. The full lines represent the part to be built (as a fixed structure) under the present contract, while the dotted lines show the additional parts to be built later when it is to be converted into a drawbridge. These additional parts include the rolling segments or segmental girders, track girders, machinery supports, operating struts, and the machinery and electrical equipment. The canal is crossed on the skew, with an angle of 68° 21' 40" between the center lines of the bridge and the channel. The main span will have through trusses 150 ft. c. to c. of end pins, and 22 ft. 3 ins. deep at the middle. These will give a clear waterway of 120 ft. (measured at right angles to the channel) between the two piers carrying the bascule spans, and the clear headway at the center will be 18.63 ft. Between each channel pier and its abutment will be a deck truss span of 97 ft. 6 ins. in length. These approach spans carry the machinery and give a sufficient waterway for the maximum flow of water from the channel. The main piers are 140 ft. long and 48 ft. wide, built of monolithic concrete,

FIG. 3.—COMPLETED SUBSTRUCTURE FOR EIGHT-TRACK DRAWBRIDGE.

(View on Jan. 5, 1900.)

capped with four 24-in. courses of rock-faced Bedford stone, and each pier has four chambers to reduce the quantity of material. The piers are placed parallel with the line of the channel and are carried down to bedrock, 44 ft. below city datum. The abutments are also of concrete faced and capped with Bedford stone. The coping of the piers is about 4 ft. above the level of water in the canal. The concrete is composed of 1 part

Portland cement, 3 parts sand and 6 parts broken stone, ... by machinery and deposited in 6-in. layers.

The ... of the railway companies to remove their tr... and leave the site clear within the time ... by the contract, caused material delay ... commencement of the construction work. ... in fact this work was not commenced until M... 1899. Two single-track timber trestles ... built by the Drainage Board on each side of ... site, and a third has since been built on the ... side in consequence of the increased as a fixed structure will be executed by the A. & P. Roberts Co. (Pencoyd Iron Works), of Philadelphia, Pa. The permissible unit stresses allowed by the specifications of the Pennsylvania Lines limited by provisions for minimum sections and special cases, were modified as follows, for medium steel:

Tension.

Bottom flanges and eye-bars	$9{,}000\ (1+\Phi)$
Floor beam hangers and similar members	$7{,}500\ (1+\Phi)$
Wind bracing	$13{,}000\ (1+\Phi)$
C. force, traction bracing and sway bracing	$11{,}000\ (1+\Phi)$

leaves will roll backward and upward, the curved heel rolling on rack plates laid on the plate girders of the approach spans, as in the Scherzer bridge at Boston, described and illustrated in our issue of March 15, 1900. The bridge is to be opened or closed in 30 secs., and will be operated by eight electric motors of 40 HP. each, four on each side of the channel, the movement being regulated from a controller in an operating tower on each side, as shown by the double dotted lines in Fig. 1. The towers will be placed on the framework supporting the machinery, so that the operator will have a clear view of the tracks and the channel.

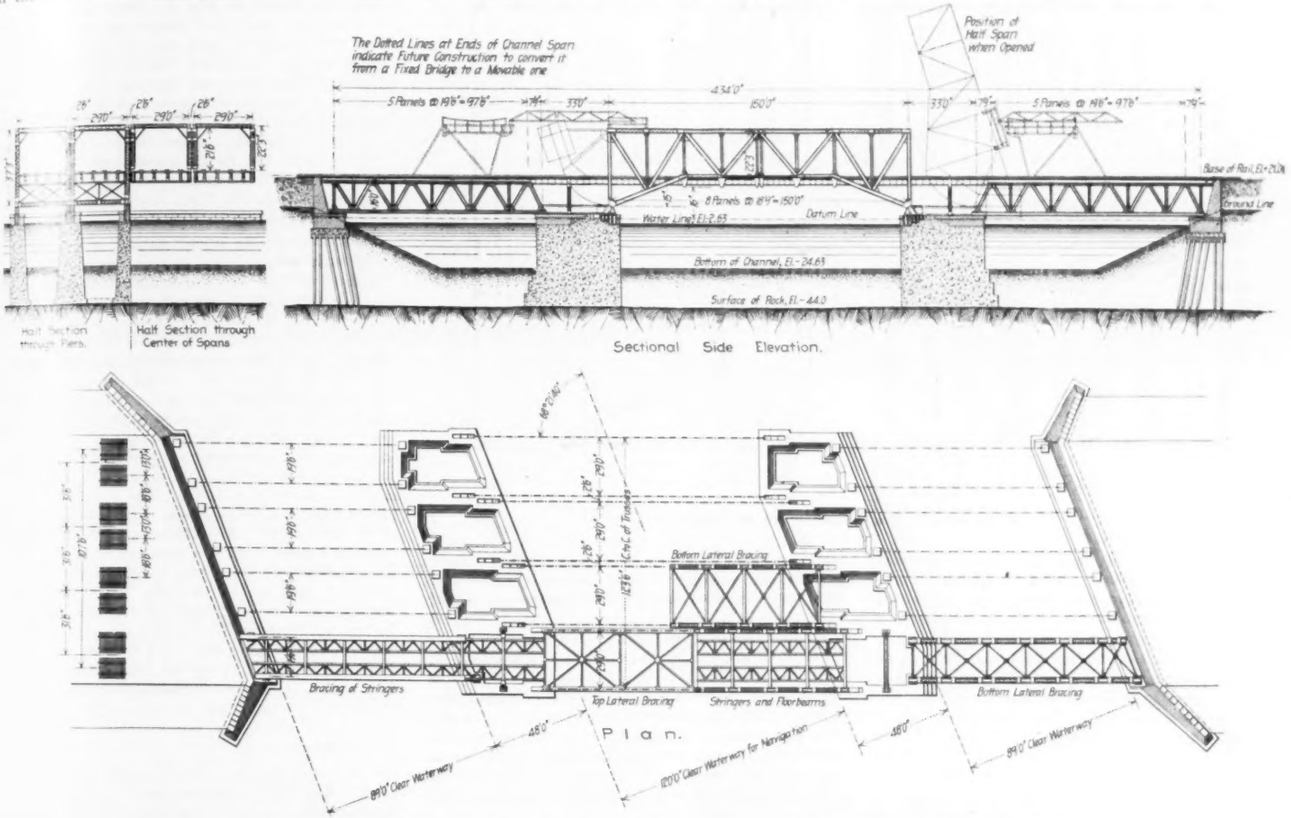

The Dotted Lines at Ends of Channel Span indicate Future Construction to convert it from a Fixed Bridge to a Movable one
Position of Half Span when Opened
5 Panels @ 196'-9 7/8"
434'0"
150'0"
330'
5 Panels @ 196'-9 7/8"
8 Panels @ 84'-4" = 1501'0"
Water Line El. 2.63
Datum Line
Base of Rail, El. + 20.0
Ground Line
Bottom of Channel, El. - 24.63
Surface of Rock, El. - 44.0
Half Section through Piers.
Half Section through Center of Spans
Sectional Side Elevation.
Bottom Lateral Bracing
Bracing of Stringers
Top Lateral Bracing
Stringers and Floorbeams
Bottom Lateral Bracing
Plan.
880' Clear Waterway
1200' Clear Waterway for Navigation
880' Clear Waterway

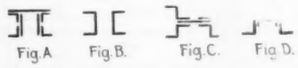
FIG. 1.—PLAN AND ELEVATION OF EIGHT-TRACK BASCULE BRIDGE FOR THE CHICAGO DRAINAGE CANAL.
Scherzer Rolling Lift Bridge Co., General Contractors.
McArthur Bros., Builders of Substructure.
A. & P. Roberts Co., Builders of Superstructure.

traffic. The Drainage Board also built the cofferdams on each side of the site, isolating it from the main channel, so that it could be pumped out. The view in Fig. 2, looking north across the channel, shows the condition of affairs on May 23, 1899, with the temporary trestles on each side, and the plate girder fixed spans still in place. The contract for the excavation and substructure was executed by McArthur Bros., of Chicago, who carried on the work night and day, in order to have it ready for the opening of the canal in January. As a matter of fact, water was let into the canal on Jan. 2 by a by-pass west of this work (Eng. News, Jan. 11, 1900), but the work was completed a few days later and water was admitted under the bridge on about Jan. 10, 1900. Fig. 3 is a view taken on Jan. 5, 1900, showing the work practically completed, and giving a good idea of the size and massive construction of the piers. The water leaves only the two top courses of masonry exposed to view.

The superstructure will consist of four parallel double-track bridges, having a clearance of about 6 ins. between the adjacent trusses, and it may be operated as one structure or as four separate structures, as desired. The design was made in accordance with the general specifications of the Scherzer Rolling-Lift Bridge Co., and the specifications for railway bridges of the Pennsylvania Lines West of Pittsburg. It provides for a loading of 5,000 lbs. per lin. ft. of single track, with a concentrated load of 50,000 lbs. at any one point. The contract for the superstructure of the bridge

Compression.

General formula	$\left\{9{,}000 - 40\frac{l}{r}\right\}\ (1+\Phi)$



Or the following special formula:

Fig. A	$\left\{9{,}000 - 103\frac{l}{h}\right\}\ (1+\Phi)$
Fig. B	$\left\{9{,}000 - 108\frac{l}{h}\right\}\ (1+\Phi)$
Fig. C	$\left\{9{,}000 - 130\frac{l}{h}\right\}\ (1+\Phi)$
Fig. D	$\left\{9{,}000 - 136\frac{l}{h}\right\}\ (1+\Phi)$
Shearing on shop rivets, mild steel	$5{,}500\ (1+\Phi)$
Bearing on shop rivets, mild steel	$11{,}000\ (1+\Phi)$
Shearing on field rivets, mild steel	$4{,}500\ (1+\Phi)$
Bearing on field rivets, mild steel	$9{,}000\ (1+\Phi)$
Shearing on field rivets, iron	$4{,}000\ (1+\Phi)$
Bearing on field rivets, iron	$8{,}000\ (1+\Phi)$
Shearing on web sheets, steel	$5{,}000\ (1+\Phi)$
Lateral struts, steel	$\left\{10{,}500 - 40\frac{l}{r}\right\}\ (1+\Phi)$

When completed for use as a drawbridge, the draw span will act as a three-hinged arch when closed, and the leaves will be counterbalanced so as to come to rest normally at an angle of 40° above the horizontal. This will facilitate the opening and closing of the bridge. When the locks are withdrawn by the electrical appliances, the

The general design of the bridge, and all the details of the superstructure were made by the Scherzer Rolling-Lift Bridge Co., and had to be approved by the engineers of the railway companies and the Drainage Board, as follows: Mr. Isham Randolph, Chief Engineer of the Drainage Board; Mr. Thomas H. Johnson, M. Am. Soc. C. E., Chief Engineer of the Pittsburg, Cincinnati, Chicago & St. Louis Ry.; Mr. J. B. Cox, Chief Engineer of the Chicago Junction Ry., and Mr. F. E. Paradis, M. Am. Soc. C. E., Chief Engineer of the Chicago Terminal Transfer Ry. The railway companies also retained Mr. Ralph Modjeski, M. Am. Soc. C. E., as Consulting Engineer in regard to the design of the superstructure, and Mr. W. M. Hughes, M. Am. Soc. C. E., acted as Consulting Engineer for Bridges for the Drainage Board.

THE NEW LOCOMOTIVE REPAIR SHOPS OF THE PHILADELPHIA & READING R. R., AT READING, PA.

(With two-page plate.)

Machine and Erecting Shop.

The largest single plant of locomotive repair shops owned by any American railway is being erected by the Philadelphia & Reading R. R., at Reading, Pa. This plant when completed will comprise a full set of shops for foundry, blacksmith, boiler making, and machine and erecting work for 100 locomotives. As already stated, it

will be located at Reading, Pa., the general repair headquarters of the road. All the buildings are to be of modern steel skeleton construction and fully provided with heating system, power cranes and hoists, electric light and power, drainage system, supply tracks, turntables, and every modern convenience and equipment of up-to-date blacksmith, foundry and metal-working shops. The power for the entire plant will be supplied from a central power house containing electric generating machinery, and complete air compressor and steam plants. At the present time the general layout of the buildings which has been drawn up is tentative, and we do not publish it here, but the location and design for the combined machine and erecting shop have been definitely settled and the contracts for construction have been awarded.

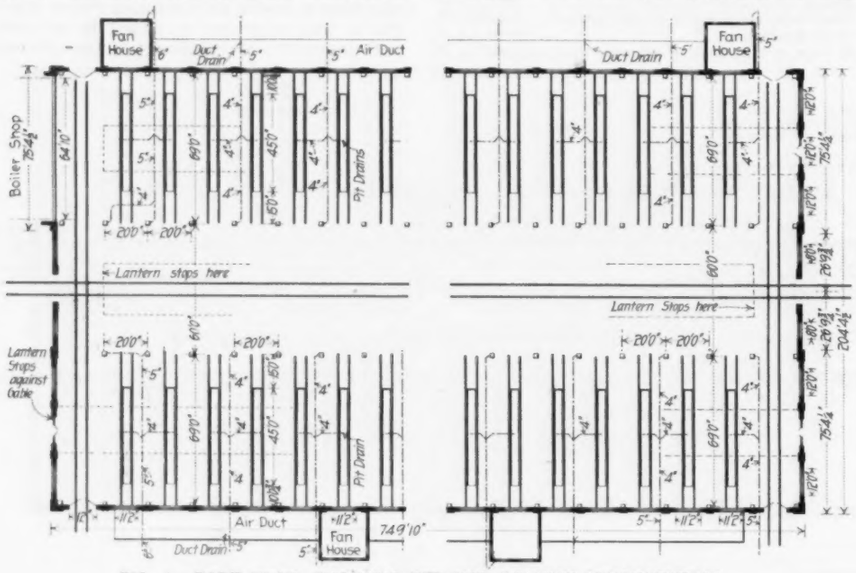


FIG. 1.—PART PLAN, SHOWING PIT AND COLUMN ARRANGEMENT.

The combined machine and erecting shop is 204 ft. 4½ ins. wide and 749 ft. 10 ins. long, with provision made for its extension to a total length of 1,000 ft. At its present length it has repair pits for 70 locomotives, and the proposed extension will provide for 30 pits more. Assuming 10% of the company's locomotives to be constantly out of commission, this provides shop accommodations for an equipment of 1,000 locomotives. So far as we know, no locomotive repair shop in America has so great a capacity as this. Fig. 1 shows the general arrangement of the shop in plan, and Fig. 2 is a transverse section showing the general character of the construction.

The building, it will be observed, is divided transversely into three bays by means of two rows of intermediate columns running lengthwise of the building. These intermediate columns and the side wall columns carry the roof trusses and the overhead cranes, and are spaced 20 ft. apart longitudinally. The walls of the building are entirely independent of the steelwork. Considering the building transversely it will be observed that the two side bays contain the repair pits; one pit between each pair of columns, 35 pits on each side spaced 20 ft. apart c. to c. Over each side bay there are two traveling bridge crane tracks, one above the other. The top track will be for a crane of 120 tons capacity, capable of lifting a locomotive and carrying it the entire length of the building at a height great enough to clear the locomotives standing on the repair pits beneath. On the lower track there will be placed a number of 35-ton cranes for handling parts of locomotives and material. The middle bay composes the machine shop, and it is also covered by a track for a number of traveling bridge cranes of 10 tons capacity each. A material track runs lengthwise of the middle bay at the center, and for bringing the locomotives into the shop there is a track extending transversely through the shop at each end. These transverse tracks connect by means of turntables with a yard track running parallel with the east side of the shop.

Taking up the construction in detail, the steelwork is the first part perhaps to demand attention. As already stated, the nature and general arrangement of the steel frame is shown by Figs. 1 and 2. It may be divided into two parts for description. The first part comprises the main columns and the traveling crane track system which they support directly, and the second part comprises the roof framing. Considering the construction of the main columns first, it will be seen that it had to be devised to withstand an unusually severe combination of loads, including not only the dead and wind loads usual to all building frames, but also a very heavy concentrated moving load from the traveling cranes. Careful attention was also required to provide means for longitudinal expansion of the columns and crane track girder system and still preserve the utmost stiffness possible in the heavily loaded crane tracks.

The interior and wall columns were substantially similar in construction, both being composed of two channel sections made up of plates and angles, held together by a double lacing of 2½ × ½-in. bars. Fig. 3 shows the column construction in detail. Each column is founded on a concrete pier with a granite capstone. The concrete in these piers and for all other foundation work was composed of 1 part Portland cement, 2 parts clean sharp sand and 5 parts stone broken to pass a 2-in. ring. In making the concrete the sand and cement will first be mixed dry and then wet, and the wet mortar will then be mixed with the broken stone as it comes moist from washing. The shape of the column piers is indicated in Fig. 2, and the columns are fastened to them by four anchor bolts for each column. The columns are finished by milling machine at both top and bottom, and are capped and stiffened at the tops to provide a bearing for the 4-ft. 1⅜-in. plate girders carrying the 120-ton crane tracks.

The track construction for the bridge cranes is shown in detail by Figs. 2 and 3. As already stated, the tracks for the 120-ton cranes are carried on plate girders resting directly on the tops of the columns, and running lengthwise of the building. These track girders are 4 ft. 1⅜ ins. deep back to back of flange angles and in spans of 20 ft., c. to c. of columns. They are milled square at the ends and the rivets in the end angles have flat heads. To allow for expansion the ends are not butted close together but are separated by a clear space of ¼-in., by the construction shown in Fig. 3. From the drawing it will be seen that each girder span has one fixed and one expansion end, the expansion being provided for by the slotted rivet holes in the bearing plate and by the space between the ends of the girders. An exactly similar expansion end construction is provided for the girders carrying the tracks for the 35-ton and 10-ton cranes. These three tracks are on the same level and the girders supporting them are carried by brackets on the main columns. This bracket and girder construction is shown by Fig. 2.

The crane tracks proper consist of ordinary railway rails laid directly on the special cover plate forming part of the top flange of each track girder, to which they are attached by stamped steel clips riveted to the cover plate. For the 120-ton cranes the rails weigh 150 lbs. per yard, for the 35-ton cranes they weigh 85 lbs. per yard, and for the 10-ton cranes they weigh 70 lbs. per yard. The joints are located over the expansion joints at each column and are spaced ⅛-in. open, the angle splices for the rails being arranged to permit expansion and contraction. The rails were rolled to the recommended Am. Soc. C. E. sections for their respective weights. The specifications require that the crane track rails must be in perfect alinement horizontally and vertically and that the gage must not vary more than ¼-in. at the maximum. To obtain vertical alinement it is specified that not more than ⅛-in. thickness of shims, each the full size of the bearings, shall be placed between the column top and the girder. The idea, it will be seen, has been to provide for the heavy rolling loads by substantial construction and accurate workmanship, and to keep the track smooth and rigid by distributing the expansion over a number of joints instead of having all the allowance made for it at one or two points.

Turning now to the roof framing, it will be seen from Fig. 2 that there is a separate roof over each longitudinal bay of the building. The roof trusses for the middle bay rest directly on the tops of the intermediate rows of columns, but those for the two side bays are carried by special roof columns rising from the main columns, as shown by Figs. 3 and 4. The trusses in each bay are connected by purlins and lateral bracing and carry lantern roofs with glazing. Details of the roof trusses, bracing and lantern roof construction are shown by Fig. 4 so fully as to make any further description unnecessary. The roof covering and the glazing in the lanterns, however, deserve brief special notice.

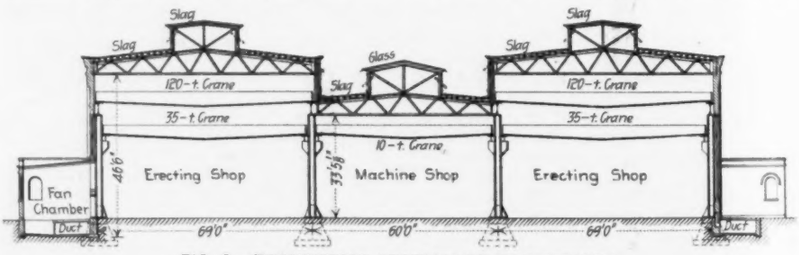


FIG. 2.—TRANSVERSE SECTION OF FRAMEWORK.

The roof covering consists first of a 1 × 8-in. hemlock sheathing, having its upper surface planed. This sheathing is to be covered by four thicknesses of roofing felt spread with granulated slag. The construction is specified to be as follows: Make the outside course next the edge of five thicknesses of felt, then lay each succeeding layer at least three-fourths of its width over the preceding layer, firmly securing it in place, and thoroughly mop the surface underneath each suc-

ceeding layer as far back as the edge of the next lap of the thin coating of roofing cement. This cement is in no case to be applied hot enough to injure the woolly fiber of the felt. At least 70 lbs. of cement should be used per 100 sq. ft. of roof. Over the entire surface of the felt laid as described above, there should be spread a good coating of cement, not less than 5 gallons (including what is used between the layers of felt) of cement being employed per 100 sq. ft. of roof. This cement coating is to be covered with a coating of slag, granulated and boiled for the purpose, using no slag larger than will pass through a ⅝-in. mesh and none smaller than will be caught by a ¼-in. mesh. This slag must be free from sand, dust and dirt and must be applied perfectly dry while the cement is hot.

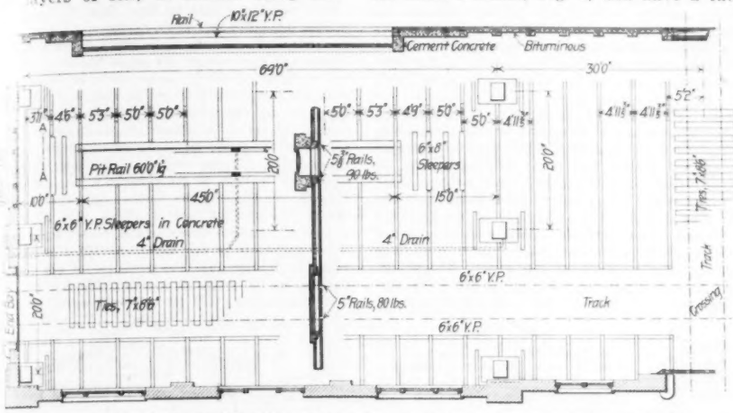


FIG. 5.—PLAN AND SECTIONS OF FLOOR, TRACK AND PIT CONSTRUCTION.

The structural features of the glazing in the windows and lights of the monitor roofs are fully shown by the drawings of Figs. 2 and 4. It will be noted that the sash in the side walls of the monitor roofs are hung on pivots at the middle of each side. There is a similar arrangement of sash in the upper side wall windows of the side roofs overlooking the low middle roof, except that the sash in alternate bays only are pivoted. These latter sash are to be provided with "Brand's" sash openers, with chains operated from the crane runways and arranged to open all the sash of one bay at one time. The feature most worthy of note, however, is that the sash in the side walls of the monitor roofs are to be operated by compressed air power from a central point on one of the side walls of the building near the floor. The sash will be operated in sections about 75 ft. long and the piping and valves will be so arranged that any one or all of the sections can be operated at one time.

Next to the framework of the building, the structural features of most interest are perhaps the pit and floor construction. This is shown in detail by Figs. 5 to 7. In constructing the floor the ground inside the building will be carefully leveled and well tamped and puddled if necessary. The entire area of the main building, except under the pits, where cement concrete will be used, and under the railway tracks, where stone ballast will be used, will then be covered with a layer of bituminous concrete. This concrete will be composed of well screened cinders and No. 4 coke oven composition mixed in the proportion of at least one gallon of composition for each cubic foot of cinders. This composition is to be laid hot and well rammed. Yellow pine floor sleepers, 6 × 6 ins. square, will be bedded in the bituminous concrete at intervals varying from 4 ft. to 5 ft. transversely of the building. To these stringers there will be spiked an under floor, or lining, of hemlock plank planed on both edges and on the upper side. On top of this lining there will be laid a flooring of 1⅛ × 4-in. maple boards of a uniform and regular width, planed on top and both edges, worked on the back to a depth of 1-16-in. and a width of 2¾ ins., laid across hemlock floor, bored on a slant for nailing and face nailed with 12d. nails, the two lines of nails in each board being staggered. The nails will be placed in lines on each side of the board and not over 16 ins. apart, and the nails in one line will be opposite the middle point between the nails in the opposite line.

The pit construction is shown by Figs. 5 and 7. The sidewalls and bottoms of the pits are made of cement concrete of the composition already described as being employed in the foundations for the main columns, Fig. 3, and have a facing of 1 in. of cement. It will be noticed that the bottoms of the pits are crowned transversely and have longitudinal side drains of "catch basin" type, running into gutters which connect with the tile drain pipe system of the building. The pit rails are carried on 10 × 12-in. yellow pine side timbers resting on the concrete pit walls and connected by anchor rods extending into the bituminous concrete floor foundation. The railway tracks in the building consist of 80-lb. rails spiked to cross-ties laid in stone ballast. For the general dimensions and all the minor details of the track, pit and floor construction, the reader is referred to the drawings of Figs. 5 to 7.

Before taking up the exterior construction of the building, a brief reference may be made to the method adopted for heating it. By referring to Figs. 1 and 2 it will be noticed that an underground duct extends along each side of the buildings. This duct will contain all the steam, air and other piping entering the building and will also serve as a hot-air duct for heating the building. For the latter purpose the duct connects with fan houses placed at intervals along the side of the building, there being four fan houses on the west side and three on the east side. It is expected that the exhaust steam will be ample to heat the building. The exact arrangement of the heating apparatus cannot be stated at present, but the general principle of its operation will be to use the air over and over again, depending upon the natural ventilation to keep it fresh. Structually the ducts are simple, their bottoms and side walls being of concrete with a cement plaster, and the roof being expanded metal and concrete supported by transverse roof beams. The roofs of the fan houses will consist of I-beams carrying T-iron purlins holding book tile, which in turn carry a felt and slag roofing similar to that already described for the main building.

From the structural point of view, the wall construction of the main building presents nothing that is particularly notable. These walls are of brick masonry resting on a concrete footing and are anchored to the wall columns, as shown by Fig. 3, but they are independent structures, receiving no support from these columns. The entire wall area is pretty well taken up with doors and windows, there being one in each panel or between each pair of wall columns, as shown by the part elevation, Fig. 8, and the north end elevation, Fig. 9. This introduces a considerable amount of arch work, but nothing that is of unusual character.

To illustrate the simple methods which have been adopted to secure a pleasing exterior appearance for the building, we have given considerable space to the presentation of some of the typical details of the wall construction in Figs. 10 and 11. It will be noticed that nothing in the general design of the details is outside of the field of the ordinary brick mason's work, yet the facades of the building have been made to present the appearance of rather elaborate architectural composition. As railway shop buildings are usually particularly bare and plain structures, it is of interest to see how a different result has been attained in the present case.

It is obvious at once that the long, low side elevation was the most difficult to handle so as to reduce the appearance of flatness due to its small vertical and large horizontal dimensions. This defect was quite successfully remedied, however, by outlining the cornice rather boldly and by merging its horizontal lines into the horizontal lines of the main and monitor roofs so as to give to the eye a strong impression of a crowning mass and thus draw attention from the great difference in the main horizontal and vertical dimensions. This effect was further emphasized by the cor-

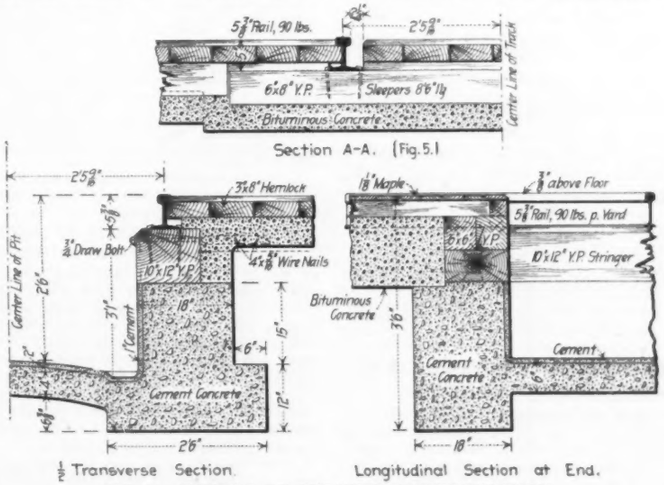


FIG. 7.—DETAILS OF REPAIR PIT CONSTRUCTION.

belling over the window spaces, while the necessary supporting strength in the wall below was suggested by the heavy and strongly marked arches over the windows and by paneling the window spaces so as to bring the narrow space of wall between them into relief and thus provide the necessary appearance of stable supporting piers between the arches.

The architect was aided materially in breaking up the wall length by the vertical division afforded by the location of the fan houses, and also by the location of the door openings. It is evident, however, that had not the economical use

of the space within the building made it necessary to space the windows equal distances apart all along the sides so as to have one opposite each repair pit, the apparent length of the wall could have been reduced by arranging the windows in groups of three and making the wall space separating each group noticeably wider than that between the windows in each group.

Turning now to the ends of the building, it will be noticed that the actual roof and wall lines form three masses substantially alike in form and magnitude. To relieve this architectural fault, the gable walls of the two side roofs were extended considerably above the actual roof line, so as to give the appearance of greater size to these side masses as compared with the center mass. At the same time the character of the center mass was entirely changed in appearance by carrying the gable wall above the actual roof line and terminating it with a horizontal cornice and coping. The effect of all these alterations was to change the original group of three equal masses, which nearly always present an unpleasing appearance, into a double group of two like masses connected by a link of unlike character. It will readily be observed from the illustrations how the grouping of the details has been designed to emphasize this composition.

The reader will be able, with a little study of the drawings, to carry this analysis further, but the essential points have been sufficiently brought out to illustrate the point which we have wished to make. It will not be pretended, of course, that such attention to architectural appearance as has just been noted does not entail some extra expense over a construction which just satisfies the simple utilitarian requirements; but this extra expense certainly does not warrant the careless neglect of the matter which is frequently observed in shop construction. It is gratifyingly apparent, moreover, that this belief is coming to be more generally appreciated nowadays than it has been in the past.

The designers for the new locomotive shops of the Philadelphia & Reading R. R., the main building of which we illustrate and describe here, are Wilson Bros. & Co., Engineers and Architects, of Philadelphia, Pa. We are indebted to Mr. Joseph M. Wilson, M. Am. Soc. C. E., and to Mr. Howard S. Richards, of that company, for the information from which this description has been prepared. In a future issue we expect to give further details of this interesting shop plant.

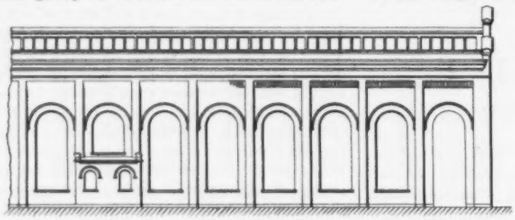


FIG. 8.—PART SIDE ELEVATION OF BUILDING.

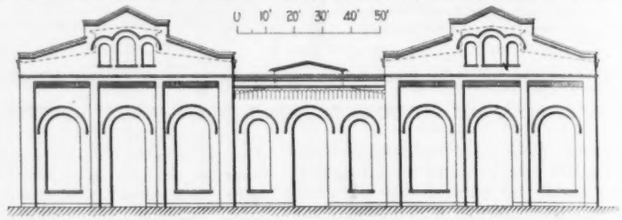


FIG. 9.—END ELEVATION OF BUILDING.

ANNUAL SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The 41st meeting of the American Society of Mechanical Engineers was called to order in the assembly room of the Grand Hotel at Cincinnati, O., on the evening of May 15. The convention was opened by an address of welcome by Mayor Gustav Tafel, of Cincinnati, who called attention to the things of general and engineering interest to be seen about the city. The response was made by President Charles H. Morgan, of the society. His remarks were reminiscent of his visit to the city 44 years before, when he had met the Latta brothers and Miles Greenwood, who introduced the first automobile steam fire-engine in America. He asked that their names should not be forgotten in their native city. In closing, President Morgan called attention to the remarkable growth of Cincinnati since his first visit in wealth and manufactures. The speeches were followed by an informal reception and smoker in the parlors and dining room of the hotel.

The Wednesday morning session was opened by a paper by Mr. Geo. P. Rockwood,

"On the Value of a Horse-Power."

This was a reprint of the paper and discussions on the subject presented before the December meeting in New York city, and which were abstracted in our issue of Dec. 14, 1899. The paper takes up the question of expert testimony before courts of law, and the further discussion on the present occasion was largely in support of the view that the matter is purely legal and had better be left to the lawyers to settle.

The following paper on

"Hot Water Heating from a Central Station,"

by Mr. H. P. Yaryan, was reprinted in our last issue. In the discussion it was pointed out that the water tanks for heat storage would need to be very large in order to store the heat delivered from the engines during any considerable period; also, as the storage tank must needs be an open tank, the pumps forcing the water through the mains must constantly operate against a head corresponding to the highest point reached by the distribution system. For the work thus expended there is no compensation, as the water flows back freely by gravity. Mr. G. P. Rockwood described briefly a hot water heating plant in a dye works, where a hot water heat storage tank was used. The tank was made quite cheaply of wood, which was also efficient as an insulator. Condensers were found to be cheaper than feed-water heaters for transferring heat from the exhaust steam to the water. Mr. W. F. Mattes held that the pipes required for the hot water distribution might better be used for the distribution of fuel gas, which would carry not only heat, but also light and power, to the consumers' premises.

"Systems of Electric Transmission in Factories and Mills."

The above paper, by Mr. W. S. Aldrich, discusses the relative advantages of the different systems of electric power distribution in shops as compared with distribution by mechanical means. The great advantages of the electric system are improved efficiency, especially at small loads, flexibility in arrangement of machinery, easy and sensitive speed control and the absence of dirt, shafts and belting. The author states at the close of his paper:

It might naturally be expected that the greatest saving would be noticed in those factories engaged in heavy machine work, where the loss in shafting and belting amounts to over 50% of the total power developed at the engine. However, many small factories have introduced electric driving to marked advantage. A few cases may be cited: (1) Electric driving reduced the cost one-half over the former method for engineer, coal and water; (2) fuel account, by electric driving, reduced to one-fifth of what it formerly was by shafting and belting; (3) cost of power, 44% lower than what it was by shafts and belts; (4) gross saving, about 30%, with direct coupled motors, and 22% with geared or belted motors.

In the discussion the simplicity and great adaptability of the induction motor for this class of work was pointed out.

The last paper of this session was on the

"Design of Speed Cones,"

by Mr. J. J. Guest, and was read by title only. It is purely mathematical, and gives a formula in some respects new for dimensioning speed cones or stepped pulleys, when the same are intended to run with open belts. The problem necessarily leads to a transcendental series, and the results can be reached only by successive approximations. It would be a great service to designers if some one would compute the values through the practicable range of sizes and speeds once for all and place them in a table where they could be used without getting a headache during the process.

A report was next read from the junior committee. The junior meetings during the winter have been very successful, and have brought out many good papers, and hereafter the papers will be printed and notices of the meetings will be sent to members of all grades in all parts of the country.

A communication was received from the Citizens' Business League of Milwaukee, Wis., inviting the society to hold the next spring meeting in that city. A similar invitation was received from Saratoga, N. Y., and the matter was referred to the council.

Wednesday afternoon was devoted to an excursion on the steamer "Island Queen" to the plant of the United States Cast-Iron Pipe & Foundry Co., located 12 miles down the Ohio River. The boat was provided with a steam calliope and a stringed orchestra, which, together with the liquid refreshments furnished by the Lunkenheimer Brass Co., helped to make the trip a merry one. At the works the visitors were shown the processes of molding and casting large cast-iron pipes.

The first paper of the Wednesday evening session was by Prof. Robt. H. Thurston, on

"Multiple Cylinder Engines."

In the absence of the author, it was read by title only. It was reprinted in our last issue.

"The Gas Engine Hot-Tube as an Igniting and Timing Device."

This paper was read by Prof. Wm. T. Magruder. It describes experiments made to determine the influence of the following elements upon the time of ignition: (1) the length and diameter of the upper hot-tube; (2) the length and diameter of the lower hot-tube; (3) the volume of the passage way leading from the admission chamber to the hot-tube; (4) the amount of compression due to the percentage of piston displacement in clearance volume; (5) a leak at the lower hot-tube pet-cock; (6) a leak by the piston rings; (7) the position of the inlet valve lever set-screw; (8) leakage of the exhaust valve; (9) the temperature of the jacket-water outlet; (10) the temperature of the mixing and ignition chambers; (11) the speed of the engine at constant jacket-water outlet temperature; (12) the temperature of the hot-tube; (13) missing of the previous explosion; (14) the pressure of the gas; (15) the position of the gas-cock handle; (16) the size of the air-inlet diaphragm; (17) the pressure at which the air was delivered to the engine. Indicator cards are given in the paper showing the influence of the various factors. The engine experimented upon indicated 9 HP. at 280 revs. per min.

"Water Softening Plant of the Lorain Steel Company."

This paper, by Mr. N. O. Goldsmith, was reprinted in our last issue. It was pointed out in the discussion that a low temperature necessitates the use of caustic lime and much time in the process, and that it would be better to raise the temperature of the water in the settling tanks to 200° F.

The next paper was read by Mr. M. P. Higgins, on the

"Education of Machinists, Foremen and Mechanical Engineers,"

supplementing his paper on the same subject read before the December meeting. The original paper was printed in abstract and discussed editorially in our issue of Dec. 7, 1899, and the present paper will be abstracted in a future issue. As before, the paper gave rise to a spirited discussion. All united with Prof. Higgins in the desire that every machinist should receive a liberal education, and that the standing of the machinist's trade should be raised as high as possible; but, on the other hand, few were inclined to agree with him that to become a professional engineer one must first be a thorough machinist. The present engineering schools are well fitted for the production of the former, but for the adequate education and training of the skilled machinist it was generally admitted that there was at present no adequate provision.

"The Automobile Wagon for Heavy Duty."

The above paper, by Mr. Arthur Herschman, is reprinted in the present issue. The subject aroused considerable interest, and there was some discussion of the relative advantages of steam and gas engines for vehicle driving. The gasolene motor, while cheap and simple to operate, has been shown to be lacking in flexibility in the matter of speed and torque. The steam motor gives almost any desired torque or speed, but involves many complicated parts, requiring constant attention. The electric vehicle was stated to be out of the question on sandy, muddy or hilly roads.

The next paper, describing

"A Test of a Fifteen-Million High-Duty Pumping Engine, at Grand Rapids, Mich.,"

was read by Mr. F. C. Wagner in the absence of Prof. M. E. Cooley. It gives a very full and detailed account of an elaborate test made in 1896 upon a Nordberg triple-expansion pumping engine. While the engine is not remarkable in itself, the paper is valuable as showing the great refinement possible in tests of this kind and the necessity of extreme care if the results of such tests are to be reliable. In working up the results many subsidiary points of considerable interest were determined.

The disposition of heat in the engine is shown by the following table. That the heat accounted for amounts to over 100% of the heat furnished arises from the fact that

...test was made with steam at boiler pressure ... causing, by the higher temperature, more ... amount of radiation:

Disposition of Heat.

	Full-speed, 3d day.	Test- ¾-speed.	½-speed.
Pressure, lbs. per sq. in.:			
Absolute	139.26	139.41	140.34
In jacket, absolute	56.57	63.79	71.87
Steam at 0.1 l.-p. for. stroke*	6.93	6.38	6.23
Average exhaust stroke, absolute	2.37	3.10	3.20
Indicated at 0.9 l.-p. ford. strke	.....	15.47	17.41
Deg. of steam in jackets & reheatrs, %	13.952	15.068	17.893
Steam sold at pressure in low-pr. jacket, heat units	258.1	266.0	274.0
Steam used in cylinders, %	86.048	84.932	82.107
Indicated gross work done in 0.9 l.-p. forward stroke	99.64	.....	.....
Heat equivalent gross work done in 0.9 l.-p. forward stroke	6.33	5.44	5.50
Heat equivalent work done in low-pr. exhaust stroke	21.57	26.42	27.02
Net heat expended on steam be- ... 0.9 l.-p. ford. stroke, H.U.	15.24	20.98	21.52
Actual heat, steam at 0.9 l.-p. for- ... stroke	914.91	912.93	883.13
Total energy lost in exhaust, H.U.	930.15	933.91	904.65
Heat carried away in jacket water	36.01	40.08	49.03
Loss by radiation	27.57	35.07	55.39
Equivalent of useful work done	199.40	190.98	183.13
Total heat accounted for	1193.14	1200.04	1192.20
Total heat at boiler pressure	1189.42	1189.44	1189.57
Excess of heat accounted for	3.72	10.60	2.63
Heat recovered from jacket water	36.01	40.08	49.03
From exhaust steam, by heater	73.85	74.82	69.81
Total heat recovered	109.86	114.90	118.84
Heat recovered in exhaust	856.3	859.09	834.84
Net heat deliv. to eng., pr lb. steam	1079.56	1074.54	1070.73
Converted into useful work, %	18.47	17.77	17.10
Lost by radiation, %	2.56	3.26	5.17
Unrecovered in exhaust, %	79.32	79.95	77.97
Total accounted for, %	100.35	100.98	100.24

*Absolute.

The engine showed a maximum performance of 135,835,000 ft. lbs. per million heat units.

"Test of the Snow Pumping Engine at the Riverside Station of the Indianapolis Water Company."

The above paper, by Mr. W. F. M. Goss, relates to a test of a pumping engine designed and constructed by the Snow Steam Pump Works for the Indianapolis Water Co., of Indianapolis, Ind. The engine is described as follows:

The engine is designed to pump 20,000,000 gallons in 24 hours. It is of the vertical triple-expansion type, having a single-acting plunger pump below, and in line with each of the three steam cylinders. The steam cylinders are 29, 52 and 80 ins. in diameter, respectively; the pump plungers are 33 ins. in diameter, and each has a stroke of 60 ins. Connecting rods from the cross-heads of each cylinder couple with cranks set at 120°, and upon the crank shaft are two 20-ft. flywheels.

All steam cylinders are jacketed on barrels and heads, and steam coils in the intermediate receivers, presenting a surface of 2,220 sq. ft., serve as reheaters.

The steam distribution is controlled by valves of the Corliss type, which close promptly when released.

A surface condenser, having 3,355 sq. ft. of cooling surface, connects with a by-pass in the main suction pipe.

An air pump and a boiler-feed pump receive motion from the low-pressure cross head, the latter drawing its supply from the hot well and delivering back to the boilers.

The auxiliary apparatus consists of a direct-acting steam-driven air pump, which, in anticipation of a start, is used to exhaust the main condenser and its connections, and a small Westinghouse air pump for use at intervals to keep up the supply of air in the several air chambers on the delivery side of the pumps. Except for these, the main engine is entirely self-contained.

The test shows the engine to have performed 17,452,000,000 ft.-lbs. of work at the pumps on a consumption of 118,346,000 British thermal units, or 147.5 million ft.-lbs. of work per million British thermal units consumed.

This is not only greater than that which had been reported for any engine up to the time this test was made, but is one which, measured from an absolute basis, is marvelously high. By it the engine is raised to the rank of a record-breaker. The fact that a year later, in the spring of 1899, its high performance was excelled* by an engine presenting novel features in design does not discredit the performance of the Snow engine, but rather enlarges the measure of the tribute due the skill and ingenuity of the American engineer.

The consumption of steam per indicated horse-power per hour is 11.38 lbs. A perfect engine, working under the same range of pressures, would require 9.2 lbs. of steam per HP. per hour. Again, a consumption of 11.38 lbs. of steam per HP. per hour, under the conditions of pressure and temperature employed, is the equivalent of 209.9 British units per indicated HP. per minute. While these results had been equaled and slightly exceeded by the performance of the Leavitt engine of Chestnut Hill, Mass., they are remarkable as having been obtained from an engine in the design of which no special or unusual effort ... made to secure minimum cylinder clearance. It would seem, therefore, that the high performance is to be largely attributed to thorough jacketing, and to a valve action which gives a distribution of steam throughout the cylinders that is altogether excellent.

*See Eng. News, Dec. 14, 1899.

"Pumping Engine Test with Superheated Steam."

This paper, by Mr. E. H. Foster, was read by title. We extract the following description and conclusions:

The engine was of the Worthington duplex direct-acting type, triple expansion, since there were six steam cylinders arranged in two tandems, three on each side, through which the steam passed successively, and termed "low-duty," to distinguish it from the "high-duty" or compensated type of engine designed to use steam at considerably higher ratios of expansion. The design of the engine is strictly commercial, more attention being paid to simplicity of construction and fewness of parts than to unnecessarily refined ideas of short ports and reduced clearances. The steam cylinders are jacketed on their sides only, where steam is carried at boiler pressure. The water accumulating in the jackets is ordinarily emitted through a throttled opening adjusted by hand, and passes through a coil in the feed tank and open at its extremity. Steam passes from one cylinder to the other through bare cast-iron pipes. The steam inlet and outlet valves are placed underneath the steam cylinders, the high-pressure cylinders alone and fitted with cut-off valves. The condenser is of the surface type, placed in the main delivery pipe of the pump, the water passing on the outside and the steam on the inside of the tubes. The air pumps, also duplex, work horizontally, like the main engine, and are driven by rods extending out from the plungers through the water-cylinder heads. The general dimensions of the engine are as follows:

Diameter of high-pressure cylinders	12 ins.
" " intermediate "	18 "
" " low-pressure "	29 "
" " air-pump plungers	7 "
" " main-pump "	14 "
Nominal stroke of all	18 "

From the results obtained we may conclude with reference to engines of this type:

(1) Steam, when superheated about 125° F. will do 16% more work than when saturated.

(2) With steam superheated, as above, and the feed water passed through an exhaust heater, a given amount of fuel will produce from 11 to 12% more work.

(3) The effect of steam jacketing all the cylinders is only to produce a saving of about 4% of the fuel, or 3% of the feed water under the above conditions of superheated steam and feed water heated by exhaust.

(4) That the use of even a small cross-over exhaust pipe between the intermediate and low-pressure steam cylinders, while somewhat beneficial to the running of the engine, causes an increase in steam consumption of about 5%.

(5) With an allowance of 2% for losses due to slip and leakage, this engine shows that it can easily perform a duty of 96,000,000 or 97,000,000 ft.-lbs. per 1,000,000 British thermal units, or of giving an effective horse-power on 18.3 lbs. of superheated steam per hour, which latter corresponds to 108,260,000 ft.-lbs. duty per 1,000 lbs. of steam; certainly a most excellent result for an engine of this class.

In a paper submitted in discussion of Prof. Goss' paper, Mr. Chas. L. Heisler described a boiler feed-pump provided with a compensating mechanism, which, when running non-condensing on 110 lbs. steam pressure, had shown an economy of 26 lbs. of steam per indicated HP.

The last paper presented before the convention, discussing

"Cylinder Proportions for Compound and Triple Expansion Engines,"

was read by title only, in the absence of the author, Mr. B. C. Ball. The paper was read before the junior meeting of March 6, in New York city. It describes a graphical method of determining cylinder proportions, by which clearance is taken into account. The author advocates the use of "drop" between cylinders.

On Thursday afternoon the members were entertained by the Triumph Ice Machine Co. at the plant of the Cincinnati Oyster & Fish Co., where they were shown a cold-storage plan in operation. The evening was occupied by a reception of the members and guests and conversazione at the Hotel Alms.

On Friday morning the members journeyed to Dayton, O., where they were entertained by the National Cash Register Co. After viewing the shops and grounds the party was taken into the convention hall of the factory and entertained with a very interesting account of the method of management and history of the works, the talk being illustrated by excellent lantern slides. This company not only pays its employes good wages for nine hours' work per day in the best lighted and cleanest shops in the country, but furnishes in addition free baths, to be used on its own time; warm lunches, served in its own dining room, at a cost of one cent a piece; libraries and reading rooms; flowers and shrubs about the grounds; night schools and clubs for the young men and women, and kindergartens for the children. It goes even further, and by advice and material encouragement assists the people in beautifying their own homes. It also takes them into its confidence and keeps them informed of the state of its business by posting each day the number of orders received and other matters of that sort. It asks their advice, too, and in a very effective way. Scattered through the shop in convenient places are autographic registers. Now, whenever a workman thinks of something that would be an improvement in the way either of processes, machinery arrangement or management he enters it on one of these registers, and in proper time it is brought up before a committee and acted upon. The company distributes a series of prizes every six months for the best suggestions received. The extra expense incurred by the company in providing for the happiness and welfare of its employes amounts to 3½% of the pay-roll, and the benefits received by the company from this course are estimated to be worth 10%, which it considers very profitable philanthropy.

After the lecture the visitors were entertained at dinner in the dining hall of the shop. After the courses were over speeches were in order, and many members of the society expressed their warm appreciation of the great success of the founders of the company, the Patterson brothers, both as business men and as benefactors of humanity.

The success of the Cincinnati meeting is well indicated by the action of the society at the closing session of Thursday morning, when a series of formal resolutions were adopted, in which Mayor Tafel, the United States Cast-Iron & Pipe Co., the Triumph Ice Machine Co. and the various other individuals and bodies which extended courtesies were thanked. The concluding sentences of the resolutions were:

Let finally it is to the local committee of arrangements in the Queen City that the members must express their warmest thanks for the labor, for the thought and for the unwearied devotion to their comfort during their stay, for the delightful success of the Cincinnati meeting. In arranging the programme, in securing facilities, in guiding wanderers about the city, there has been no element of kindly effort left untouched to make the Cincinnati convention a memorable one. We would ask that the local committee as a whole, and its chairmen of subcommittees individually, will rest assured of heartfelt appreciation on the part of those for whose pleasure their efforts have been expended.

Table Comparing Results of Tests of Snow and Nordberg Engines.

		Snow Steam Pump Works.		Nordberg Manufacturing Co.	
1.	Name of designer or builder				
2.	Locality	Indianapolis, Ind.		Pittsburg, Pa.	
3.	Type	Triple expansion.		Quadruple expansion.	
4.	Extent of jacketing	Barrels, heads and recvrs.		Barrels and receivers.	
5.	Name of expert conducting test	Prof. W. F. M. Goss.		Dept. of Exper'l Eng., Sibley Col.	
6.	Capacity million gallons in 24 hours	20		6	
7.	Size of steam cylinders, ins	29, 52, 80 × 60		19.5, 29.0, 49.5, 57.5 × 42	
8.	Size of water plungers, ins	33 × 60		14.75 × 42	
		Test of	Test of	Test with heaters,	Test without heaters,
9.	Date of test	July 8, 1898...	Dec. 3, 1898	March, 1899.	March, 1899.
10.	Total head, lbs	88.7	89.2	261.5	
11.	Piston speed, ft. per min	214.6	211.8	255.6	
12.	Pressure near throttle (above atmosphere), lbs	155.6	154.6	200.0	
13.	Ratio of expansion	23.8	22.4		
14.	Indicated horse-power, I. HP		782.9	712.2	
15.	Friction, per cent		6.2	6.95	
16.	Dry steam per I.HP. per hour, lbs.*		11.38	12.26	11.4
17.	Per cent. of steam conden'd in jackets and reheaters		6.2		
18.	Dry steam per I.HP. per hour, lbs.†		11.67		
19.	B. T. U. per I. HP. per minute		209.9	185.96	
20.	Duty based on 1,000,000 heat units, exp. in mil. ft.-lbs.	150.1	147.5	162.9	147.5

*Including jacket and reheater steam. †Exclusive of steam used in jackets and reheaters.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Injury by Electric Light Wire.

An electric light company which brings a high-tension wire within a few inches of a house, where it is defectively insulated, is liable to a person injured therefrom while engaged in a lawful occupation about the house; contributory negligence not being shown.

Brown vs. Edison Electric Illuminating Co., of Baltimore, 45 At. Rep. (Md.), 182.

Municipal Water Plants.

Laws N. Y. 1875, c. 181, authorizing the villages of the state to furnish their inhabitants with water, provides, among other things, that, if the board of water commissioners deem it necessary, they may condemn and acquire the rights and properties of an existing corporation. This power, the Supreme Court holds, is optional with the village only, and an existing company has no power to compel the village water commissioners to purchase or condemn its rights and property. The court also holds that the provisions of the chapter for the taxation of property to cover the deficiency when the net water receipts are insufficient to pay the indebtedness when due, and which establish a scale of rates for the use of water, and also rates for fire protection, when the owner or occupant of the property affected does not use the water for domestic or manufacturing purposes, are not essential features of the act, and being in contravention of the federal constitution, may be eliminated.—Skaneateles Water-Works Co. vs. Village of Skaneateles, 55 N. E. Rep 562.

Grade Crossings.

On an application to define the mode of crossing a steam railroad by a trolley road, a map, filed by the petitioner, showing that the route of a trolley road crosses the railroad at the point where the mode of crossing is to be defined, is sufficient, though it does not exhibit any indication of a crossing. Under P. L. 1852, p. 268, requiring a railroad company to construct bridges or passages over or under its railroad where any "roads shall cross the same and to alter and grade the said roads so that carriages, horses and cattle, passing and repassing shall not be impeded thereby," the railroad has the right to cross a highway at grade. On an application to define the mode of crossing a railroad by a trolley line, the question is whether, taking into account the danger of collision, and facility and economy with which it may be avoided by adopting a crossing other than at grade, the latter method should be required.

In re West Jersey Traction Co., 45 At. Rep. (N. J.), 282.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The controversy now going on between the Naval Hydrographic Office and the U. S. Coast Survey, as to a class of work that has long been successfully performed by naval officers, seems to be promoted by congressional feeling rather than by any actual conflict between these two bureaus. In any event the general public will not profit much apparently from the readjustment of duties, as outlined in the late action of Congressman Cannon. This gentleman succeeded in having the naval, ocean and lake survey appropriations cut from $100,000 to $10,000; but as these surveys had to be made by someone, he adds over $300,000 to the Coast Survey appropriation for apparently performing the same work. The last action taken is the suspension of Commander C. C. Todd, Hydrographer to the Navy, and an officer of high standing and reputation, for alleged "duplicity"—whatever that means. Commander Todd has promptly demanded a court of inquiry.

As to the merits of the case, there are certainly advantages in having all surveys connected with our coast, harbors and lakes performed under one executive head; to the end that this work may be done economically and without duplication of effort. On the other hand, however, naval officers are vitally concerned in the charts of our harbors and the sea-roads which they travel; they are fitted by their training to make surveys of this character, and they have ships at their disposal that are maintained at government cost for other purposes. There seems to be, therefore, good reason why they should perform this work as well as anyone else, and do it at less cost to the government. The coast survey must equip and maintain vessels intended for this purpose alone; and it looks very much as if the increased appropriation advocated by Mr. Cannon for the Coast Survey measured the difference in cost under the two systems. The naval officers of other nations make these surveys, and some means should be devised to employ our own officers usefully in similar work, whenever it is more economical to perform it under naval direction. An earnest desire for promoting the best interests of the government should find means for adjusting all present conflict of authority or duplication of work.

The American Water-Works Association held its twentieth annual convention at Richmond, Va., last week. From the report of the meeting, given elsewhere in this issue, it will be seen that a number of timely and interesting papers were presented, a few of which were of unusually high merit. The discussions on the papers, while more extensive than our report would indicate, for reasons explained below, was hardly up to the usual level. The discussions at the meetings of this association often fall below their proper level, and are often comparatively limited in extent, owing to the crowded program and the fact that the papers are rarely printed and distributed in advance of their presentation, contrary to the practice of many of the other national societies devoted to engineering and allied topics. In our report of this particular convention, we give none of the discussion on papers presented during the first four sessions, owing to the adoption of a resolution at the opening session, which requested the technical press not to report such discussion. This restriction was removed when the convention was half over and another one passed forbidding the official stenographer to give out his notes prior to their revision by those taking part in the discussion. The first of these resolutions was so contrary to accepted practice in all fields of journalism, and such an unmerited blow to the technical press, as to be open to severe criticism, but against the second resolution we have nothing whatever to say. The notes taken by the official stenographer, barring some arrangement with him to the contrary, are the exclusive property of the association, and subject to its control; but to shut out the technical press from reportorial privileges freely accorded the daily papers is quite another thing.

An even more absorbing incident of this convention centered around a pamphlet circulated by the association last winter, purporting to be the report, or abstract of such, of a committee appointed by the association to memorialize the Congress and President of the United States for the enactment of laws against water pollution. On investigation it appeared that this pamphlet was never submitted to the committee, nor signed by any member except the secretary. Some idea of the character of the pamphlet may be gained by reading the brief abstract of a subsequent production by the author, included in our report of the Richmond convention, under the heading, "A New Definition of Water." Further information regarding the pamphlet and its consideration by the convention will be found in our report of the proceedings.

CONTRACTS AND QUANTITIES IN THE NEW YORK RAPID TRANSIT RAILWAY WORK.

The awarding of the subcontracts for the New York rapid transit railway work during the last few weeks furnishes a striking illustration of the enormous quantities of labor and engineering material which will be consumed in carrying this great project to completion. On April 16 the Carnegie Steel Co. took the contract to manufacture 74,326 tons of structural steel and about 4,000 tons of steel rails for this work. The same day a contract was also awarded to the United Building Material Co. to supply to the same work 1,500,000 barrels of cement. These contracts are, respectively, the largest, we believe, that were ever undertaken by individual firms for supplying cement and steel for a single engineering work. Up to the present time other individual contracts for the same work have been awarded, the figures for which are, respectively, $1,125,000, $2,000,000, $1,600,000, $2,000,000, and these include only a part of the contracts which have been or will be awarded before the whole road is brought under construction. Something of a mental effort is required, as we read over these large numbers to realize fully that they represent merely the items of labor, quantities and expenditure, which combine to make up a single engineering w[illegible]. For most persons, indeed, some further a[illegible]ysis is necessary in order to comprehend their e[illegible]re purport.

Of the two contracts for supplying [illegible]ctural material, which have been mentioned pa[illegible]ularly, that undertaken by the Carnegie Steel [illegible] is in some respects the most notable. Accord[illegible] to the itemized statement which has been publ[illegible]ed this contract requires the Carnegie Works [illegible] manufacture 22,439 tons of steel beams, 20,4[illegible] tons of riveted steelwork, 7,921 tons of steel colu[illegible]s, 21,500 tons of steel viaduct, and 4,064 ton[illegible] of steel rails, or a total of 78,390 tons of finish[illegible] steelwork. It has already been stated that t[illegible] is the largest contract for steel ever undertak[illegible] by a single steel-maker for a single engineerin[illegible] work. It is as much steel as would be required to lay 556 miles of railway track with 80-lb. rails. The ordinary pin-connected single track railway bridge of 200 ft. span will weigh approximately 135 tons, so that no less than 580 such bridges could be built with the steel which will be manufactured for the rapid transit road.

Comparing these figures with another class of bridge work, we find the nearest approach to them in the amount of steel employed in constructing the Forth Bridge in Scotland. In this great structure, with its two 1,700-ft. spans and total length of 5,310 ft., exclusive of approaches, about 58,000 long tons of steel were used. Approximately 3,200 tons more were required for the approaches, making a total of 61,200 long tons, or 73,440 short tons, of steel consumed in the entire work. As will be seen, this total amount falls about 1,000 tons short of the 74,326 tons of structural steel required for the rapid transit railway. With the steel which will go into the rapid transit tunnel, therefore, the engineer could duplicate the greatest bridge superstructure in the world, and have nearly a thousand tons of material left over, or enough to build another Atbara Bridge for the British war operations in the Soudan.

A fact which should not fail to be observed, however, in comparing the supply of steel for these two structures is that: while the steel for the Forth Bridge was made by several manufacturers, that for the rapid transit railway will, as already stated, be manufactured by one firm. Nevertheless the contract of the Steel Works of Scotland to manufacture 38,000 long tons of steel for the Forth Bridge was until the present rapid transit railway contract probably the largest one ever undertaken by a single steel-maker for a single structure. Indeed, the contract was in some respects a more noteworthy one than that of the Carnegie company for the rapid transit road. In 1887, when the Forth Bridge contract was undertaken, steel was not the universally used material that it is to-day. For most structural work wrought iron had the preference among engineers. Iron had been used throughout for the Brooklyn Bridge, completed a few years before, except, of course, in the main cable and suspender construction, and the great Eiffel Tower, with its 7,300 tons of metal, was built entirely of wrought and cast iron.

The building of the Memphis Bridge, which is next to the Forth Bridge, the largest cantilever bridge in the world, required 8,160 tons of steel. All but about 1,200 tons of this steel was made by the Carnegie Steel Co., under several contracts with the various shops which did the structural work. The bridge and viaduct work for the Pittsburg, Bessemer & Lake Erie and Union railways completed in 1898, consumed 22,096 tons of structural steel, all of which was manufactured and erected by the Carnegie Steel Co. Neither of the two works last mentioned come at all near the Forth Bridge or the rapid transit railway in the amount of steel consumed, although in the general run of steel bridge work they would both be reckoned as rather notable structures for the tonnage of steel employed. In tall steel skeleton building construction the record for the greatest tonnage of steel used is held by the Ivins Syndicate Building in New York, in the manufacture of whose framework 9,000 tons were employed, or more than was required to build the Memphis Bridge superstructure. To summarize briefly, the structural steel needed for the rapid transit railway work would build the Memphis Bridge, all the

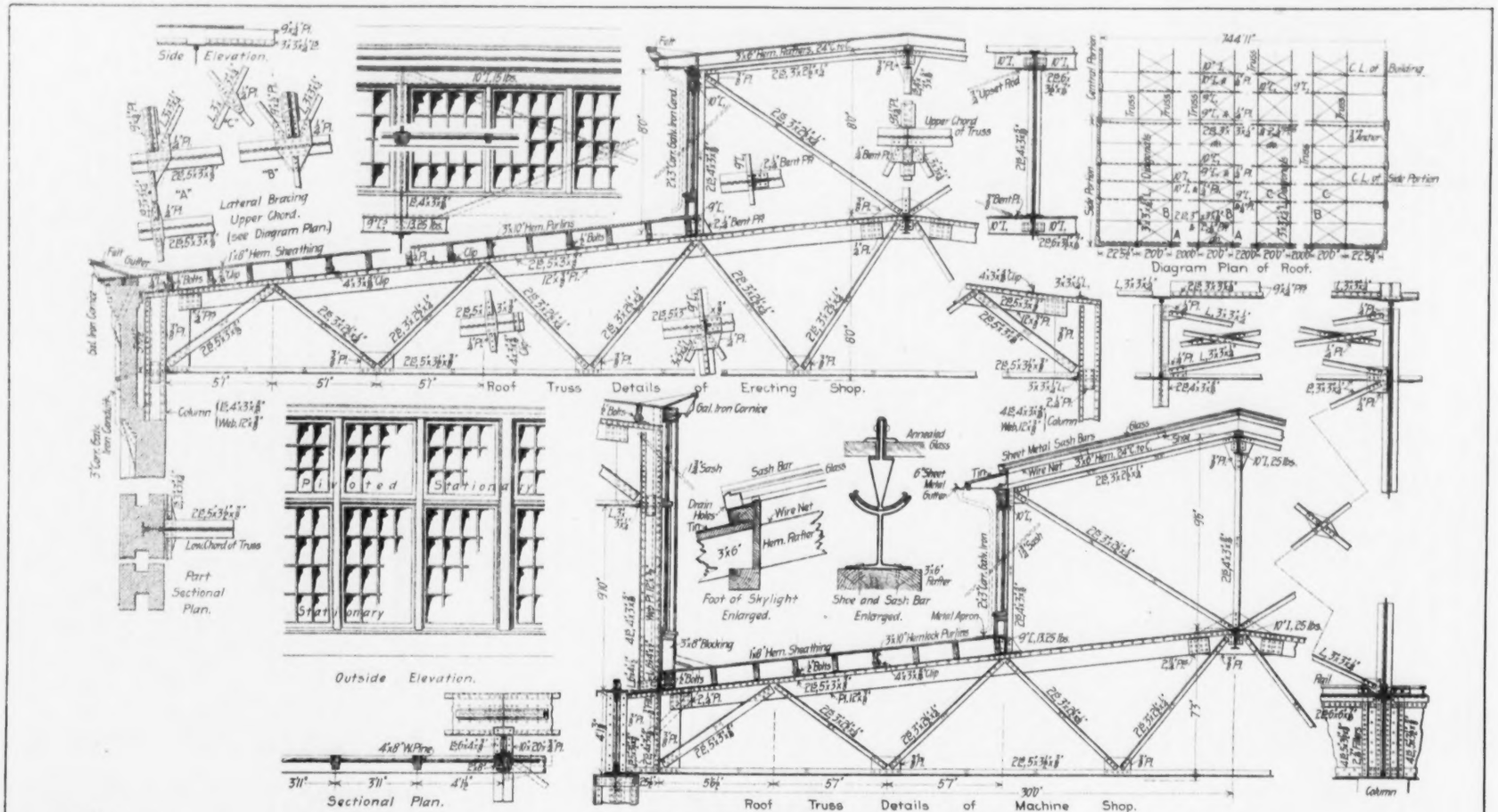
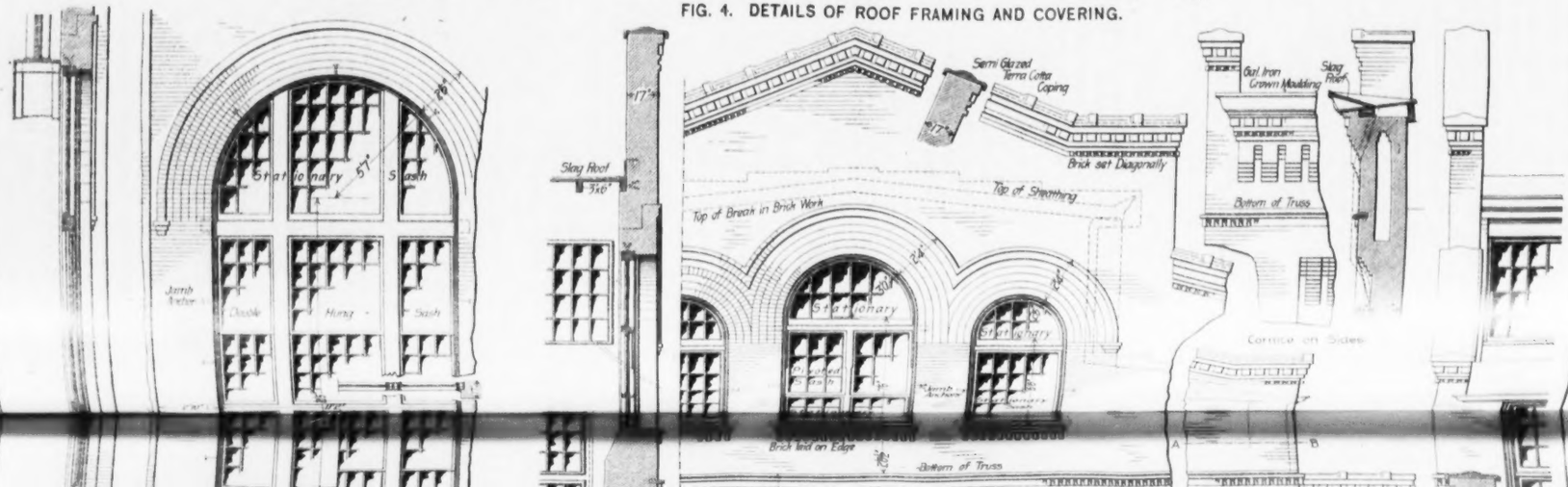

Side Elevation.
Lateral Bracing Upper Chord. (see Diagram Plan.)
Roof Truss Details of Erecting Shop.
Diagram Plan of Roof.
Part Sectional Plan.
Outside Elevation.
Sectional Plan.
Foot of Skylight Enlarged.
Shoe and Sash Bar Enlarged.
Roof Truss Details of Machine Shop.

FIG. 4. DETAILS OF ROOF FRAMING AND COVERING.



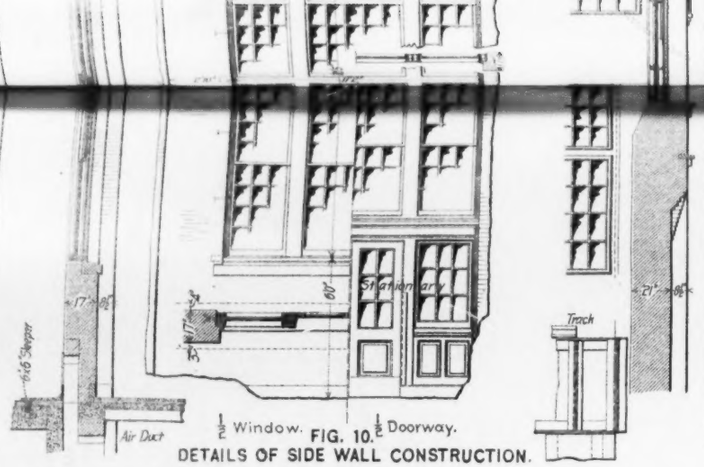


FIG. 10.
DETAILS OF SIDE WALL CONSTRUCTION.

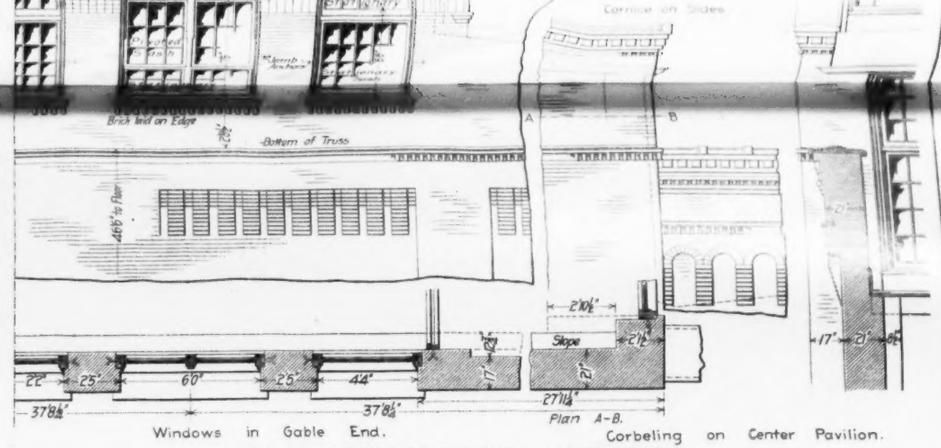


FIG. 11. DETAILS OF END WALL CONSTRUCTION.

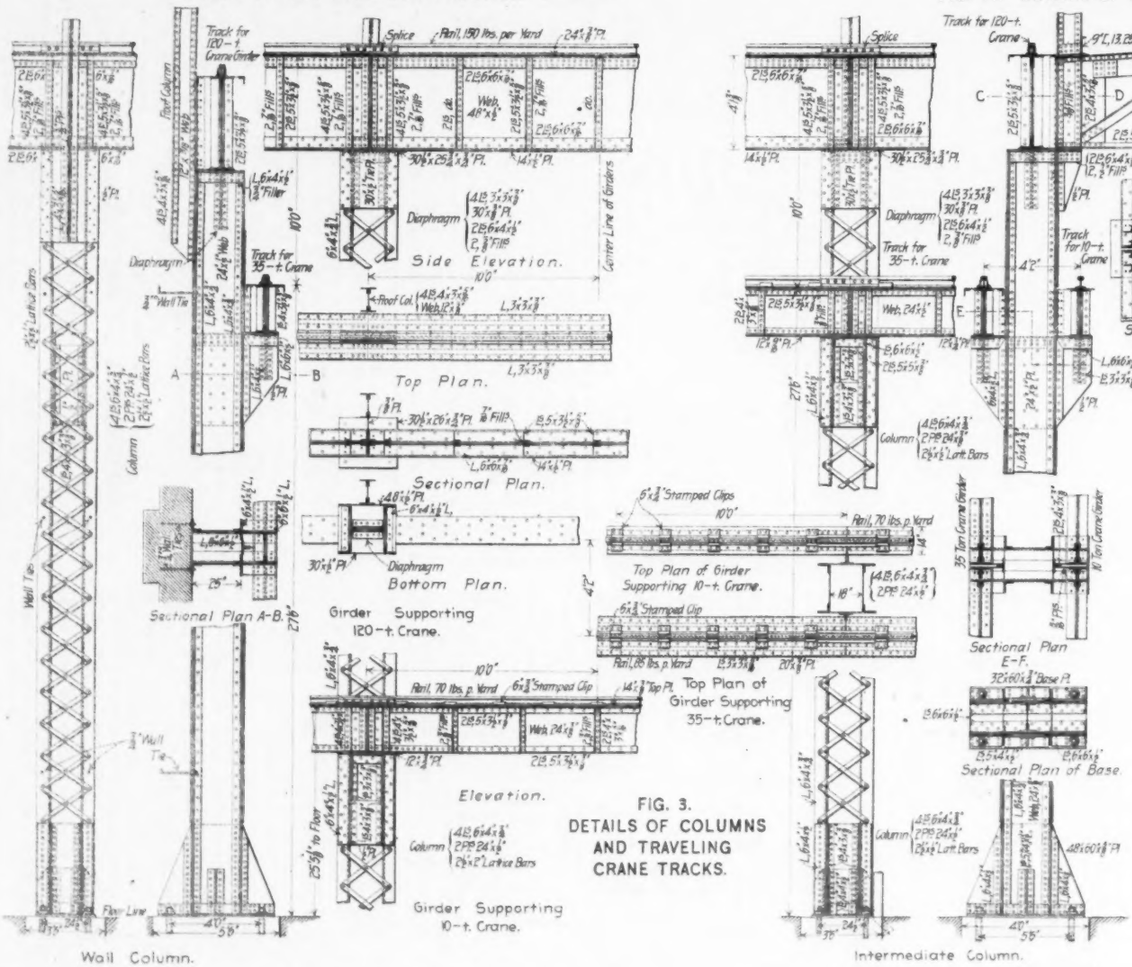


FIG. 3.
DETAILS OF COLUMNS AND TRAVELING CRANE TRACKS.

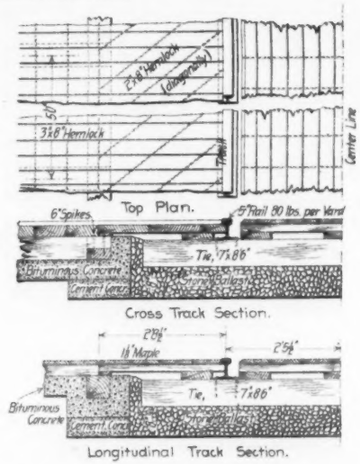


FIG. 6. DETAILS OF FLOOR AND TRACK CONSTRUCTION.

LOCOMOTIVE ERECTING AND MACHINE SHOP; PHILADELPHIA & READING R. R., READING, PA.

Wilson Bros. & Co., Philadelphia, Pa., Engineers and Architects.

Phoenix Bridge Co., Phoenixville, Pa., Contractors.

CHAS. HART, LITH., 26 VESEY ST., N. Y.

bridges and viaducts for the Pittsburg, Bessemer & Lake Erie and Union railways, and come within [illegible] of completing five buildings of the size of the Syndicate Building, which covers an area of [illegible] sq. ft. in plan and is 30 stories high. Next to the Forth Bridge the largest bridge structure upon which actual construction has ever been undertaken is the New East River Bridge, now being erected at New York city. This structure, according to the engineers' calculations, will contain 47,000 tons of steel of all kinds. Of this total amount 5,000 tons will be employed in the cables, suspenders and their fittings, and approximately a couple thousand tons more will be in the form of castings. Fully 40,000 tons of the metal-work of the bridge will, therefore, be high-class structural steelwork. While the contracts for this work have been divided among several persons, the requirements of the engineer for acid steel of a particular quality has so far necessitated the purchase of all of the material from a single maker, who stands in the best position to produce it in the large quantities required. The largest single contract so far let has been that awarded to the New Jersey Steel & Iron Co., for manufacturing and erecting the towers and end spans containing 12,225 tons of riveted steelwork. The contract which stands next in size is that recently awarded to the John A. Roebling's Sons' Co. for the 5,000 tons of cable and suspender work. This is probably the largest contract for supplying high quality wire for suspension bridge cable work ever undertaken by a single firm.

While the subject of the consumption of steel in long span bridge structures is in mind, it is interesting to notice briefly the estimated weights of the steelwork for the two bridges which have been proposed to cross the Hudson River at New York city. The older of these bridges, which, as many of our readers will recall, is a stiffened suspension bridge of 3,100 ft. span, designed by Mr. Gustav Lindenthal, M. Am. Soc. C. E., is estimated to require 150,000 tons of steel to construct. The second structure, a cantilever bridge, with a center span of 3,000 ft., it was estimated would consume fully 200,000 tons of steel.

Returning to the steel contract for the rapid transit railway, the fact that a single American steel works stands ready to-day to undertake such a contract in the ordinary run of business, must strike anyone who gives it a little thought as a remarkable illustration of the development of the steel industry in this country, and, indirectly, of the magnitude to which individual aggregations of capital and plant have grown in this industry. The rapidity with which this growth has been reached is quite as impressive as the size which it has attained. Less than twenty years ago the announcement that a contract of the character and proportions which have been described had been undertaken by a single steel works would have been received with incredulity. By English steel-makers alone would the accomplishment of such a task have been considered even remotely possible. Every year scores of articles are published to show the vast proportions which have been attained by the steel works of the United States, but we doubt if many of them can claim to present the fact more forcibly than the readiness and ease with which this single order for steel was placed by the builders of the rapid transit railway. The illustration becomes still more impressive when we remember that there are several steel manufacturers in the United States capable of carrying out successfully a contract of this magnitude in the ordinary course of business.

The important factor which steel has become in the work of the constructing engineer is strikingly presented by what has been said. Probably no manufactured material more justly deserves to rank second in his work than hydraulic cement. If we take the rapid transit railway work as a criterion this is certainly the case. It has already been stated that the contract for supplying cement for this road is the largest ever undertaken by a single firm for a single engineering work. In round figures this contract calls for 1,500,000 barrels, or approximately 300,000 tons of cement. Of this total amount about 1,250,000 barrels will be Portland cement. The significance of these figures is perhaps best made plain by a few comparative statements. In 1895, or say five years ago, all the Portland cement works of the United States had an annual output of less than 1,000,000 barrels, and in 1886, or fifteen years ago, less Portland cement was consumed annually in the United States than will be used in this one piece of work. In 1899 the production of Portland cement by American makers was in round figures 5,000,000 barrels, and in addition about 2,250,000 barrels more were imported to supply the consumption. On the basis of their output for 1899, therefore, it would require the almost continuous operation of all the cement works of the United States for three months to turn out the amount of Portland cement which will be employed in the rapid transit railway work.

The great bulk of the 1,500,000 barrels of cement supplied to the rapid transit work will be consumed in making concrete for the foundations and the lining of the tunnel sections. Altogether about 490,000 cu. yds. of concrete will be employed for this purpose. To make this concrete the cement must be mixed with from 2 to 2½ times its bulk of sand, and from 4 to 6 times its bulk of broken stone. Together the concrete and the steel may be fairly said to represent the rapid transit structure in the raw state. The amount of other structural material which will be used is insignificant in comparison. Outside of the cost of the manufactured steel and concrete, therefore, the bulk of the expenditure for the rapid transit railway will be for labor.

Compared with the cost of the labor the cost of the materials going to make up the rapid transit railway is small. Some idea of the magnitude of this item of labor has already been given by the figures of cost of the contracts for construction which have been awarded. Expressed in quantities of work to be done it involves the excavation of 1,700,000 cu. yds. of earth and 1,290,000 cu. yds. of rock; the removal of all this material except 773,000 cu. yds. of earth, which will have to be filled back into the excavation, from the line of the work; the laying of 775,000 sq. yds., or about 160 acres, of waterproofing; the laying of 57 miles of railway track, and the placing of 490,000 cu. yds. of concrete as some of the principal items, besides the erection of 74,326 tons of structural steelwork.

It requires only a cursory consideration of the figures which have been given to show the practical advantages which existed in dividing the rapid transit railway work into a number of independent contracts. In the first place the different kinds of work, such as viaduct, rock tunneling, earth tunneling, submarine tunneling, open cut excavation, could be let to contractors whose previous experience in similar work fitted them particularly to conduct it successfully in the present case. The subdivision, moreover, made it possible for contractors, with moderate capital and backing, to undertake contracts small enough to be within their means and ability to handle without danger of failure. In case of the failure of an individual contractor to carry out his work satisfactorily, necessitating possibly a reletting, there is a set-back only to that portion of the work which he is doing, the work on the neighboring sections being unaffected by the delay. By subletting the work, also, it was brought within the reach of a larger number of contractors, and the advantages of a more widespread competition was secured.

In conclusion, it deserves to be noted that the general contract for constructing and operating the rapid transit railway is one of the largest ever undertaken by a single company. Indeed, we cannot recall off-hand any other contract comparable to it in all respects in the history of modern engineering works.

LETTERS TO THE EDITOR.

Hollow Concrete Blocks Proposed for New York Bulkhead Walls.

Sir: In your issue of Nov. 9, 1899, an article is published describing the use of 3,000-ton concrete blocks in the breakwater of the ship canal at Bruges, and the adaptability of the method of construction used in building them to the building of bulkhead walls for the New York water front occurred to me. I desire the use of your columns for the purpose of a brief description, in the hope of inviting discussion on the subject.

The concrete blocks at Bruges were constructed hollow and designed to float 4 or 5 ft. out of water, launched when built, towed to site and sunk in place, as desired. The system of construction at present employed in building bulkhead walls on the New York water front consists of placing solid concrete blocks of from 20 to 50 tons in weight on a pile foundation, the top of the block reaching to about low water. On top of these blocks is placed granite masonry in 2-ft. courses till the desired elevation above high water is reached. The maximum size of the concrete blocks is limited by the lifting capacity of the derrick that is to set it in place, and the minimum size is determined by the required stability of the wall.

It has seemed to the writer that by the use of hollow concrete blocks economy of construction could be secured by the elimination of the expense of the large and powerful floating derricks used in setting the blocks in position in the wall, while economy of cross section might be secured from the increased stability of the longer and heavier blocks employed. The blocks could be built up by the use of suitable board forms, with thin bottom and side walls, designed only to withstand the water pressure. A layer of tar paper embedded in the walls would insure water tightness, while if extra lightness was desired a mesh of wire netting or expanded metal could be imbedded in the concrete at points of maximum pressure. Hollow blocks of almost any desired length could be built up in this way by using frequent partition walls to secure transverse strength. The blocks, when concrete had set, could be floated, towed to the site and sunk in place with concrete filling. The use of a cheaper grade of concrete for filling also presents itself as a possible economy.

The present plans of the Dock Department call for placing the top of blocks at about low water, and, of course, if hollow blocks were used the top would have to extend to high water. This, however, is a minor detail, as in the sewage saturated water of New York harbor granite and concrete are hard to distinguish after a short immersion.

Yours truly,

Francis Lansing Pruyn, Assoc. M. Am. Soc. C. E.
84 Broadway, Brooklyn, N. Y., May 16, 1900.

Notes on Cape Nome Gold Fields.

Sir: As Cape Nome and the adjacent shore of Alaska bids fair to create an excitement equal to or greater than Klondike did in 1897; and since no authoritative statement has appeared in your paper which would give data from which anyone could make designs or estimates of dredging or other machines, I beg to present a few facts relative to that country; premising the same with the statement that I have not been to that region myself, but have gathered the information from reliable sources and have checked it quite thoroughly by seeking it from several parties, and that I have considered it sufficiently reliable to base my own estimates and make designs therefrom.

The country may be roughly divided into the mountains, the strip of tundra reaching from them to the shore, and the shore lands including the beach and foreshore. Of the value of minerals in the mountains little is known, save that quartz veins are numerous in the country rock, which is slate. The same may be said of the tundra section, which has been but little prospected except where creeks from the mountains cross-cut it. In these cases very rich claims have been worked. As the same creeks show high values in gravel bars well up into the mountains, this is by no means conclusive evidence that the tundra is gold-bearing anywhere beyond the region covered now or at former times with gravel outcast by the creeks.

It was from the shore lands that the most general results were obtained. The pay dirt is a stratum of sand and gravel, overlying the blue clay, from 6 ft. to 10 ft. in thickness and running in size from very fine sand, carrying flour gold, with large quantities of ruby sand, up to flat, dish-like "nigger-heads," the size of a dinner plate, of slate. The largest of these latter are at the mouths of the creeks, diminishing in size until, at a point intermediate between the creeks, they are only 3 or 4 ins. in diameter. Owing to the wave action on the beach, stratification of the various sands and gravels is much confused. A strata of nearly pure white quartz sand was the most distinctive feature. As this carried no iron or ruby sand, it was cast aside for a considerable part of the working season. Later, upon investigation, it was found to be the richest of all the pay dirt; but it had been so carelessly thrown into the offcast that it would not pay to handle by the primitive methods in vogue. Also, owing to the lack of proper apparatus, a considerable part of the fine gold in the gravel handled was lost (estimated at 30% to 50%), although every style of riffle and all the ordinary forms of burlaps, brussels, etc., were tried. This was due to the extraordinary quantity of ruby sand, which choked the riffles and clogged the burlaps in an incredibly short time. Notwithstanding all these drawbacks, this pay dirt returned $10 to $15 per cu. yd.

The shore above tide line held good pay. Between high and low water marks (a strip from 40 ft. to 60 ft. wide, as the tides in Behring Sea are only from 2 ft. to 2½ ft. rise) the pay is better. And on the occasion of a heavy

off-shore blow for two days, which exposed about 100 ft. more beach than the usual low water, some considerable amount of sand was obtained beyond low tide line, which panned 40 cts. to $1 per pan of 1-150th of a cu. yd.

Whether these values continue to any considerable depth is as yet undetermined, because nothing was taken from more than a foot below the surface. The beach sands have usually been poorest at and near the top, and it is probable this holds good in this case.

The working season covers about 100 days, during which time washing goes on almost continuously, as these days are 24 hours long. The prevailing winds are on shore blowing half a gale all the time, and the consensus of opinion is to the effect that any attempt to anchor dredgers within the limits which have been proven to be rich pay dirt (about 5 ft. of water at low tide) will surely result in the beaching of such craft. This pay dirt limit is about 200 to 250 ft. from high tide mark, well inside the surf line, and in consequence both the water and the top 6 ins. of sand are kept constantly agitated.

The temperature of the sea water is but little above the freezing point, precluding any ordinary working in it, and anyone intending to use "quick" in gathering gold should remember that the low temperature will make it more sluggish and less able to absorb a quantity. Just what the proportions are cannot be given now, but enough to be apparent to the eye in the first case.

The climate is admitted to be beastly, as one can well understand when he remembers that the wind has just blown over a sea in which the winter's ice has recently melted. One miner made the striking simile, "'Twas like spending a rainy summer in an ice house with the roof blown off."

Yours truly,

A. McL. Hawks.

Tacoma, Wash., May 15, 1900.

WATER PURIFICATION AT NORFOLK, VA.

One of the papers read last week at the Richmond convention of the American Water-Works Association was entitled "The Norfolk, Va., Filter Plant," by Mr. Edmund B. Weston, M. Am. Soc. C. E., of Providence, R. I. The paper included quite an extended detailed description of the type of mechanical filters used at Norfolk, and comparatively little regarding the interesting developments leading up to the adoption of a filter plant. We give below the portions of Mr. Weston's paper describing the points of particular interest pertaining to the Norfolk plant, prefaced by a review of the conditions preceding its establishment, and followed by more detailed statements on the operation of the plant than are given in the paper. Our information on the development and character of the Norfolk water supply is drawn chiefly from the annual reports of the water-works department for some fifteen years past, supplemented by statements recently made to a member of the editorial staff of this journal by Messrs. H. L. Smith, Superintendent of the water-works at Norfolk, and W. T. Brooke, City Engineer.

Norfolk had a population of 34,871 in 1890. The water-works were built by the city in 1872, and the introduction of sewers was begun a number of years ago. The supply is taken from a number of lakes or reservoirs, formed by throwing dams across creeks or other streams. From the annual reports of the water commissioners, it appears that for many years past, if not from the start, the water has been of an unsatisfactory character. Thus, in the report for 1886-7 the commissioners state:

> The character and quality, however, of the water supplied is far from satisfactory, and this is caused in the main by the fact that the lakes from which it is derived are formed in most instances by damming the water back upon land which is not the natural bed of the water, whereby all the vegetable matter upon and in the soil that it is there made to cover, has so corrupted it as to make it, in many cases, unfit for use.

The commissioners go on to say that to clean the beds of the lake is out of the question, because of its great expense, and that even if that were done there would be great pollution from the fertilizers and vegetable organic matter on the drainage area.

In his report for the same year, Mr. Smith states that the well-grounded complaints regarding "dark color and general impurity of the water during the past four or five months" was largely due to previous low water in Lake Lawson, which left "a large part of its bottom exposed to the action of the sun and air." Vegetation sprang up, which had been submerged by subsequent high water. Besides the resulting decomposition, Mr. Smith believed "that the deep muddy bottom of Lake Lawson tends much to render the water impure."

In the report for 1887-8 it is stated that during the year there had been removed from the surface of Lake Smith some of "the sodden floating islands of muddy turf and polluting vegetable matter, which are taken up from the bottom by the action of the water." It was estimated that there were still four acres of these islands afloat, 2 ft. thick "and very heavy." To remove them it was necessary to tow them ashore and cut them up. This lake, although filled in November, 1886, had not been put in use up to June 30, 1888, and apparently was not drawn on until March 1, 1889, its site having been flooded

> with the full knowledge that for some years the vegetable and foreign matter on such bottom would have to be gradually taken up by the water and from year to year be passed off by evaporation, bleaching and wasting over the waste weir, gradually becoming fit for use.

During the year 1888-9, still more of this floating turf was removed, and the superintendent recommended that the work should be continued every summer, or as long as the turf came to the surface, for though its removal was "tedious and expensive," it was "indispensable to the rapid purification of that source of supply."

From the report of the city bacteriologist on the tests of the filter plant, near the close of this article, it will be seen that quite recently another large reservoir was built on this same plan of flooding a large area of bottom land and letting the reservoir stand full for some time before putting it in use, in order to give some of the organic matter time to decompose and pass away.

For a number of years it was hoped that a satisfactory supply might be developed from driven or artesian wells, but atempts to that end proved futile, although not abandoned until 1898. Meanwhile some means of removing taste and odor from the existing supply were almost constantly under discussion. Mechanical filtration was recommended in 1887, and on July 1, 1888, an aerating plant, built for $3,000 by the National Water Purifying Co., of New York, was put in operation. Although this plant had stopped "the disagreeable odor," the superintendent, a few months later, considered it a partial relief, only, believing they would never "approximate anything like a pure and satisfactory water" until mechanical filtration was adopted. The aerating plant is not described in the reports, further than to state that the contractor had agreed to substitute a 12 × 18-in. air compressor for the 8 × 12-in. Ingersoll compressor originally furnished, which the superintendent believed was altogether too small. This aerating plant introduced compressed air, through perforated pipes, to one of the reservoirs. In the summer of 1889, the aerating plant was not started until June 17, owing to there having been so much wind and rain previously. It was still credited with improving the water, "especially as evidenced by the absence of the disagreeable odor which it formerly emitted." In the report for 1889-90 the pumping engineer states that the air compressor is too small for the consumption, which averaged about 3,000,000 gallons a day. This general complaint was renewed the following year. In 1892-3 the air compressor was operated 168 days. No mention of the co[mpressor] seems to be made the following year, an[d] the report for 1894-5 it is merely stated to be [in good] condition. Two years later it was repor[ted that] no air had been sent to the reservoirs du[ring the] year, and that the air had been applied [directly] to the water in the force main for awhile, [but soon] discontinued. In the report for 1896-7, [Geo.] T. Wright, Chief Pumping Engineer, sta[ted that] when the water in the reservoirs was ac[idified he] "noticed a large growth of long, fla[t-leaded] grass," which he believed was due to a[eration.] The growth had not appeared during [the past] two years, when there had been no aera[tion, but] another kind of grass had appeared. By [changing] the course of water through the reservoirs a better circulation had been secured, and "a large quantity of grass" had been "dislodged f[rom the] bottom" and was being removed from the surface. No growth of grass occurred the following year. With the completion of the filter plant the air compressor was removed from its position and stored.

Fig. 1.—Plan of Water Purification Works, Norfolk, Va.

During the year 1896-7, new commissioners and a new superintendent having come into office, a report was made by one of the commissioners and the superintendent in favor of slow sand filtration. The conclusions of this report were that a plant operating at a rate of not to exceed 5,000,000 gallons a day, would give "satisfactory hygienic results," and would remove "the color, taste, albuminoid ammonia and the organic matter with which it (the water) may be, by accident, contaminated." The process would also "remove the vegetable growth to such an extent that the water can be metered when necessary." These conclusions seem to have been based mostly on a visit to the Experiment Station and city filtration plant, both at Lawrence, Mass. During the two years this administration was in power the water commissioners secured from the council an appropriation of $250,000, based on estimates of $200,000 for an additional water supply, and $50,000 for slow sand filtration, the filter plant to have a daily capacity of 5,000,000 gallons. In October, 1898, Mr. J. W. Ledoux, M. Am. Soc. C. E., of Philadelphia, submitted plans and estimates for slow sand filtration, placing the cost of the plant at $150,000. The water commissioners thereupon investigated the systems of the New York Filter Manufacturing Co. and the Continental Filter Co., visiting a plant installed by the former company at Elmira, N. Y. Bids were invited for mechanical filters, on the basis of 6,000,000 gallons capacity per 24 hours. In November, 1898, a contract for a plant of this capacity was awarded to the New York Filter Manufacturing Co. for $55,000. A contract for a filter house, large enough to hold filters with an aggregate capacity of 8,000,000 gallons a day, was awarded to a local contractor for $23,000. Subsequently the capacity of the plant was increased to 8,000,000 gallons.

Previous to the award of these contracts others had been made for dams, waste weirs, canals and accessories necessary to impound a large quantity of water on Little Creek, at a price of $117,840. The work also connected with the pumps such of the old sources of supply as it was desired to retain in use, thus enabling the commissioners to close and remove a number of subsidiary pumping stations. Mr. W. T. Brooke, City Engineer of Norfolk, was the engineer for the improvements other than those covered by the filter contract, Messrs. Smith and Wright co-operating with him. Mr. Weston was consulting engineer for the work done by the New York Filter Manufacturing Co., and the necessary plans and specifications were made under his direction.

The following description of the new purification works, which include subsidence, coagulation and mechanical filtration, is drawn from Mr. Weston's paper, mentioned at the opening of this article, the matter having been re-arranged somewhat for use here. The plant was put in operation in August, 1899.

The water to be treated is drawn from a reservoir known as Lake Wright, to which the water from the other impounding or collecting reservoirs flows by gravity. From Lake Wright the water flows into an adjacent subsiding reservoir, of about 5,000,000 gallons capacity, formerly used

...ary reservoir. Here the coagulant is ...rally making possible a coagulation ...nce of 15 hours, prior to the 25 min... ...d in the tanks beneath the filters. ...filters were first started the coagulant ...ted to the water just before it reached ..., but it was found that this did not ...nt preliminary subsidence and coagu... ...om the filters the water passes to a "tank valve" and regulates the flow and keeps the solution at the requisite level in the gravity tank. From the gravity tank the solution flows by gravity through a 1½-in. lead pipe, about 650 ft. long, to the entrance of the inlet chamber of the supplementary subsidence basin (subsiding reservoir.—Ed.), where it is thoroughly mixed with the incoming water which passes by four baffle boards in the inlet chamber. The solution in the tank which is supplying the gravity tank is kept thoroughly mixed by an air pump, which forces air up through it at specified periods.

Each of the three solution tanks is fitted with a gage glass and graduated rod, by means of which the sulphate of alumina solution can be carefully measured and regulated to the desired amount.

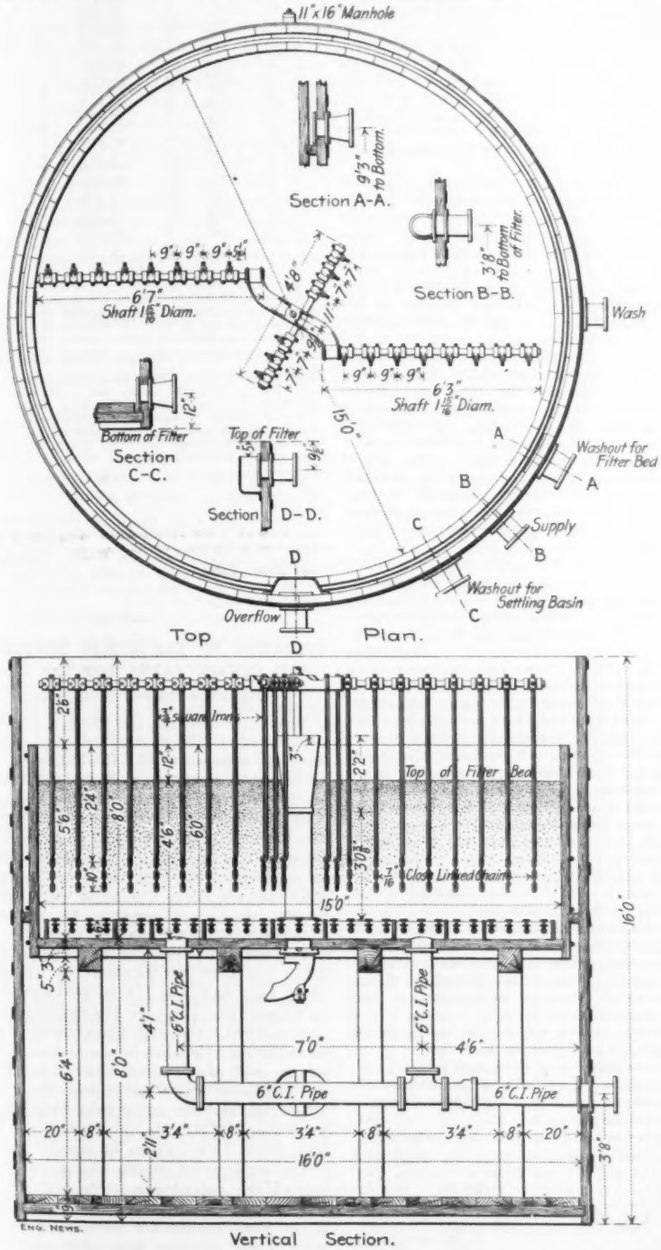


FIG. 2.—PLAN AND SECTION OF FILTER AND COAGULATING TANK, NORFOLK, VA.

1,000,000-gallon clear water reservoir, near by, from which it is pumped directly to distributing mains, under direct pressure. Fig. 1 is a sketch plan of the purification works.

The preparation and introduction of the coagulant is described in the paper as follows:

About two grains of sulphate of alumina, on the average, are used per gallon for coagulating the raw water at Norfolk. Three cypress wood tanks, each 8 ft. high and 6 ft. in diameter, are used for preparing the sulphate of alumina solution, and feeding it to the raw water. Only one of these tanks is in service at a time for feeding the solution to the raw water. One of the remaining two tanks is held in reserve, full of the prepared solution, and the other is used for mixing the solution.

From the solution tank, which is in service, the solution flows through a "tank valve" to a small gravity tank. A ball-float in the gravity tank is connected with the

The solution is prepared by first filling the solution tank being used for the purpose with filtered water, and then weighing out the proper quantity of sulphate of alumina and placing it in the tank upon a grating, with which each tank is supplied. This grating, upon which the sulphate of alumina is readily dissolved, is suspended at the top of the tank, about 3 ins. below the surface of the water. The sulphate of alumina after being dissolved is thoroughly mixed by forcing air into the tank. The sulphate of alumina solution is prepared by using proportions of about 1 part of sulphate of alumina, by weight, to 18 parts of filtered water.

The subsiding reservoir is divided into two main compartments and two small ones by means of sheet piling, the two latter serving as inlet and outlet chambers. The main compartments are both used, except when one is being cleaned, at which time only 6 instead of 15 hours subsidence is possible. It is estimated that it will take four days to clean each division, and that cleaning will be necessary three times a year. Further description of the subsiding reservoir may be quoted from Mr. Weston's paper, as follows:

A drainage pump, for pumping out the deposit in the basin when it is cleaned, is located in a small pump-house which is shown at the lower part of the basin at the left of the suction chamber (Fig. 1). The suction pipe of this pump terminates in two parts—one in the lower end of each of the two main divisions of the basin.

To aid in cleaning, there is an open drain built in the bottom of each of the two large divisions in the basin. The drains are constructed of plank and are 4 ft. wide and 1 ft. deep, and run, centrally, from the gates in the triangular division wall at the upper end of the basin to the suction pipes of the drainage pump.

Each of the two main divisions in the basin is cleaned as follows: (1) The water is drained out of the division which is to be cleaned. (2) A sufficient quantity of water is let into the central drain from the triangular enclosure at the upper end of the basin and the drainage pump started, thereby establishing a rapid current through the drain. (3) The accumulated deposit is scraped or pushed into the drain, where it mixes with the current of water and flows to the suction pipe of the drainage pump. The water and deposit is then raised by the pump about 10 ft. and then flows by gravity through a pipe about 200 ft. long, leading from the pump-house to some marsh land, which is drained by a natural creek.

Nearly all of the suspended matter originally contained in the raw water, as well as a large percentage of the bacteria and color and the greater part of the precipitate of aluminum hydrate brought about by the addition of the sulphate of alumina, is removed in the passage of the water through the supplementary subsidence basin.

There are 16 filters, each bed having a bed 15 ft. in diameter, and an outside tank diameter of 16½ ft. At a rate of about 127,000,000 gallons an acre the daily capacity of each bed is 500,000 gallons. The raw water is first admitted to the subsiding tank beneath the filters. The operation of this tank is described by Mr. Weston as follows:

The water, as it enters the subsidence basin, is given a circular motion around the basin by a deflecting flange, in which the supply pipe terminates. The upright timbers which support the filter-bed tank and the pipes in the interior of the basin all tend to produce counter currents and eddies. The rotary movement and counter currents and eddies bring about a much quicker subsidence than would otherwise be the case in a stationary tank or in a straight unobstructed current of water, as they cause the coagulated particles to meet with and overtake each other, and they are consequently thrown into juxtaposition, thereby forming much larger masses of greater specific gravity.

When it is necessary to wash out the subsidence basin, the wash water, after it has passed up through the filter-bed, is made to overflow down through the central stand-pipe into the subsidence basin, instead of being allowed to flow over into the annular trough. The water as it enters the subsidence basin from the stand-pipe, is thrown with considerable violence by a curved nozzle against the lower sides and bottom of the basin. The curved nozzle, which is shown in Fig. 2, at the bottom of the stand-pipe, is fastened to the same vertical shaft that carries the agitator and revolves with it. From the subsidence basin the dirty water flows to waste.

In the first twelve filters installed the filtering material was composed of 2 parts of sand to 1 of crushed marble, the sand having an effective size of 0.4 and a uniformity coefficient of 1.9. The last four beds are composed of sand alone. The marble was used before it was learned that the water contained sufficient alkalinity to combine properly with the coagulant.

The automatic controller for maintaining a constant flow of water through the filters is shown in detail by Fig. 3. It is described by Mr. Westons as follows:

The controller is connected (outside of the filter) to the draft or delivery pipe of the filter, from which the filtered water passes through butterfly valves in the lower part of the controller. The controller contains a float mounted on a hollow float-stem operating in guides at the top and bottom of the controller. Beneath the float is a deflector, designed to quiet the incoming water and reduce any currents, thereby giving a smooth entrance to the discharge tube and being aided in this respect by the flaring ring at the top of the discharge tube. Mounted also upon the float-stem at a fixed distance below the float, so as to be maintained at a constant depth, is a disk which is turned with a thin edge and sharp corners and of such a diameter as will give the annular orifice, between the disk and the walls of the discharge tube and which rises and falls with the float, a predetermined area proportional to the desired rate of discharge. The float being mounted at a fixed distance from the disk, thereby maintains a constant head of water upon the movable annular orifice. The inlet butterfly valves in the lower part of the controller are operated by levers connected to the float, so that the rise and fall of the latter tends to close and open them.

The regulation of the flow of water through the filter-bed may be described as follows: With a given head of water upon the surface of the filter-bed and a free discharge from the filter, the rate of discharge will vary with the condition of the filter-bed. If, for a given level of water in the controller, the head on the inlet pipe be such that more water will pass through the inlet butterfly valves than can be discharged through the annular orifice, the level of the water in the controller will rise, and with it the float, which will tend to close the inlet butterfly

valves and throttle the flow so that equilibrium is established between the supply to and the discharge from the controller. If, on the other hand, the head on the inlet pipe, be reduced, and consequently the flow through the butterfly valves, the water level in the controller falls and the float falling with it increases the opening of the valves and thus restores the equilibrium. Should the head on the inlet pipe be reduced below that determined by the minimum limit, the water level in the controller will fall below the minimum limit, the float will be submerged less, and consequently the head on the annular orifice and discharge tube will be diminished below the minimum desired. This will indicate a needed washing of the filter-bed, which is manifested at Norfolk by an indicating water gage, that is actuated by a float in a vertical pipe which is connected to the inlet pipe of the controller. The rated capacity of discharge may be adjusted by altering the depth of submergence of the disk, or by changing the area of the annular orifice by substituting a disk of different size. Air is admitted below the disk through the hollow float-stem, which has vents below the disk.

Tests have been made with this design of controller under heads ranging from 0.33 to 18 ft., and have not shown any practical measurable variation in the discharge.

A laboratory has been provided at one side of the engine-room, 11 × 15 ft. in plan. It was designed by Mr. Wright.

Regarding the cost of constructing and operating the filter plant, Mr. Weston makes the following statements:

From figures given me by Mr. H. L. Smith, Superintendent of the Norfolk Water-Works, and Mr. Geo. W. Wright, the Chief Engineer, I have estimated the cost of the filter plant to be:

Filter building and foundations	$23,341.98	
Filters and their auxiliaries	74,083.33	
Pump for supplying the filters	1,690.00	
Electric light equipment, etc.	693.00	
		$99,808.31
Work upon supplementary subsidence basin, including drainage pump, etc.		4,690.00
Total cost		$104,498.31

From figures furnished by the superintendent and the chief engineer of the water-works, the actual cost of

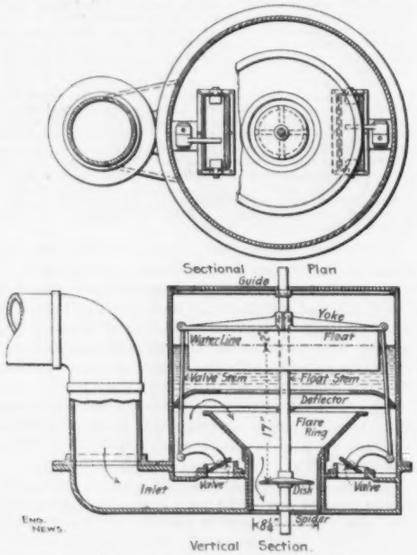


Fig. 3.—Details of Effluent Controller.

operating the filter plant at Norfolk during the month of March, 1900, has been estimated to be $5.47 per 1,000,000 gallons of available filtered water. If the filter building had not been located adjacent to the pumping station, however, and new men had been required to take the place of some of the men employed in the pumping station who devote a portion of their time to the work of operating the filter plant, the cost would probably have been about $5.80, namely:

Labor	$1.13	
Coal at $3 per ton, for supplying the water and washing the filters, etc.	.86	
Cleaning supplementary subsidence basin	.08	
		$2.07
Sulphate of alumina, 1.95 grs. pr gall., at $1.20 per 100 lbs.*	3.40	
Additional labor required if pumping station was not adjacent to filter building	.33	
Cost of operating		$5.80

Interest and sinking fund have not been considered in the estimate, nor the cost of repairs, as there was no charge for the same.

As we understand it, the above figures include nothing for the original cost of the 5,000,000-gallon subsiding reservoir, except the division walls and other changes necessary to make it available, and nothing for the 1,000,000-gallon clear water reservoir.

*Including that required for washing.

Through the courtesy of the water commissioners of Norfolk we are able to present a copy of the report on the 30-day official test of the filter, made by Dr. J. J. McCormick last October and November, as follows:

Norfolk, Va., Nov. 10, 1899.

Honorable Board of Water Commissioners, Norfolk, Va.:

Gentlemen.—In compliance with your instructions, I began on Oct. 10, 1899, the 30-day guarantee test of the filter plant constructed by the New York Filter Co., for the city of Norfolk. This test was to determine: (1) The reduction of color, which it was guaranteed would be 90%; (2) The reduction of albuminoid ammonia in suspension, which it was guaranteed would be 90%; (3) The reduction of bacteria, the guarantee being that if there were 7,000 bacteria in the raw water to the cu. cm., they would be reduced 97%. If there were less than 7,000 bacteria per cu. cm. in the raw water there would be less than 100 cu. cm. in the filtered water.

The samples of raw water were taken at a point about 25 ft. from where the water enters the reservoir for collection. The samples of the filtered water were taken from the flume at the north end of the filter plant, where the water flows into the brick reservoir to be pumped to the city.

The average reduction in color of the filtered water was 93.6%. The only time that it fell below 90% was on Oct. 16, when it registered 85%. This was due to the sulphate of alumina being reduced to 1½ grains per gallon. I should state here that this plant was constructed to filter the Lake Smith and Lake Lawson waters, as it was the most sanguine expectation of your department that it would be two years before the Little Creek water could be used. Upon the completion of the filter plant the Little Creek water was found by analysis to be available, so the guarantee test was made upon this water. The color of the Little Creek water by the platinum-cobalt standard is 99, the color of the Lake Smith water by the same standard is 30, and as the quantity of sulphate of alumina requisite is directly proportional to the intensity of color, we have 99 : 30 :: 2½ : x = ¾.

In other words, if the test had been made on Lake Smith water only ¾-gr. per gallon would have been necessary. I am informed by your superintendent that the Lake Smith water was originally the color of the Little Creek water, and took two years to attain its present color. The same rule should apply to the Little Creek water. The method of determining albuminoid ammonia in suspension being arbitrary, I determined the total albuminoid ammonia in the raw and filtered waters and found an average reduction of 94.1%, which is remarkably satisfactory. The average number of bacteria per cu. cm. in the raw water was 356; in the filtered water, 12; giving a reduction of 95.99%. The cultures were made in gelatine bouillon of 15% acidity. This medium, according to the best authorities, gives the maximum growth. The great increase in bacteria on Nov. 1 and 2 was due to a heavy rain storm. The raw water on those days was very turbid.

You will observe: (1) That the guaranteed reduction in color of 90% has been exceeded, as the average reduction was 93.6%, and this, in spite of the fact that the test was made on a water over three times as highly colored as the one upon which the test was intended to be made. (2) That the guaranteed reduction of albuminoid ammonia of 90% has been exceeded, as the test shows 94.1% reduction. (3) That there was an average of 356 bacteria to the cu. cm. in the raw water; therefore the guarantee is that there shall be less than 100 per cu. cm. in the filtered water. The average number per cu. cm. in the filtered water was 12, greatly exceeding the guarantee.

The accompanying tables show the results in detail.

I desire to express my appreciation of the courtesy and assistance rendered me by Mr. Geo. W. Wright, Chief Engineer of the Water-Works.

Very respectfully, J. Jett McCormick.

Results of Chemical Analyses to Determine Albuminoid Ammonia in Raw and Filtered Water at Norfolk, Va.

	Oct. 20.	Oct. 30.
Raw wafer: Free	0.055	0.125
Albuminoid	1.4	2.23
Filtered water: Free	0.045	0.12
Albuminoid	0.132	0.05
Reduction of albuminoid ammonia	90.57%	97.75%

A later report by Dr. McCormick, giving the average of analyses to April 1, 1900, of water taken from various taps in the city, contains the following figures and comments:

Free ammonia	0.052
Albuminoid ammonia	0.297
Nitrogen as nitrates	0.001
Nitrogen as nitrites	Trace.
Chlorine	54.0
Required oxygen	6.5
Total residue	910.0
Loss on ignition	285.0
Alum	0.0
Bacteria per cu. cm.	21.0

The organic matter shown by the test for the ammonias, nitrates and nitrites is remarkably small in quantity for a water obtained from ground rich in vegetable matter and passed through newly cut canals. The chlorine is high, but this is due to the proximity of the sea. I have recently analyzed a water from this section in which the chlorine showed 217 parts per 1,000,000, four times as much as the city water. The most delicate test gives no trace of alum. The bacteria from each weekly culture have been differentiated and proven to be without exception ordinary water bacteria, which are perfectly harmless to the human body.

Bacterial and Color Tests of the Norfolk Filter Plant, Oct. 10, to Nov. 8, 1899.†

Date.	Bacteria per cu.cm.; —water— Raw.	Filtered.	Time after wash'g, hrs.	Reduction.	Color. Raw water	Color. Reduction
Oct. 10...	280	25	3	91.07%	10	95%
" 11...	165	5	11	96.96%	10	95%
" 12...	305	10	12	96.72%	10	95%
" 13...	215	10	11	95.55%	10	90%
" 14...	190	10	8	94.73%	10	95%
" 16...	...*	20	9	.....	10	85%
" 17...	230	7	4	98.95%	10	90%
" 18...	350	6	5	98.28%	10	95%
" 19...	170	3	7	98.23%	11	97%
" 20...	580	20	3	96.55%	11	95%
" 21...	125	4	1	96.80%	11	97%
" 23...	415	13	2	96.80%	11	97%
" 24...	340	12	5	97.64%	11	97%
" 25...	290	13	4	95.51%	11	95%
" 26...	235	1	4	99.57%	11	95%
" 27...	175	2	7	98.85%	11	95%
" 28...	155	8	2	94.83%	11	92%
" 30...	250	6	3	97.60%	10	95%
" 31...	215	12	3	94.41%	8	95%
Nov. 1...	1,715	32	4	98.15%	50	95%
" 2...	1,110	36	5	96.75%	50	95%
" 3...	290	27	7	90.68%	60	95%
" 4...	220	16	8	92.72%	60	90%
" 6...	220	16	9	92.72%	100	90%
" 7...	315	14	8	95.55%	100	90%
" 8...	180	7	6	96.11%	100	90%
Average...	356	13	6	95.99%	30	93.6%

*Lost; gelatine liquefied.
†Rate of filtration, 100,000,000 gallons per acre per day; amount of sulphate of alumina used as coagulant, 2½ grs. per gall., except on Oct. 16, when only 1½ grs. were used.
‡Cobalt standard.

In conclusion, one more quotation from Mr. Weston's paper may be given:

A test of one week, which has recently been made with the Norfolk filter plant, when the same quantity of sulphate of alumina per gallon, was used, and when the average number of bacteria in the raw water was 3,404, has shown a bacterial removal of 99.51%. During this latter test the average number of bacteria in the filtered water was 14 per cu. cm.

OPERATION OF THE BERLIN SEWERAGE SYSTEM AND SEWAGE FARMS FOR THE YEAR 1898-9.*

By Allen Hazen, M. Am. Soc. C. E.†

The Berlin sewers, according to the fiscal report for the year 1898-9, received the sewage from an average population of 1,773,782 people. The total quantity of sewage was 20,000,000,000 gallons, an average of nearly 31 gallons per inhabitant daily. The grades in the Berlin sewers are light, owing to the flatness of the land, and considerable sediment accumulates in them. Accordingly, 10,600 cu. yds. of material were removed from the sewers, and 7,800 cu. yds. from the pump wells, or altogether 18,400 cu. yds. of material, being 1 volume of sludge to 5,373 volumes of sewage.

The sewage is pumped at a cost of $182,000, or $9.10 per 1,000,000 gallons. Of this cost a little more than half was for 46,000 short tons of coal, at $2 per ton. The care and cleaning of the sewers cost $76,000. The city is constantly buying more land for its irrigation farms, the total area owned at the end of the fiscal year being 28,400 acres. Of this area, 15,200 acres had been prepared for irrigation, and the actual area irrigated during the year was 14,500 acres, the average rate of application being 3,800 gallons of sewage per acre daily.

The application of the sewage to the land required 186 attendants, each taking care, on an average, of 77 acres. Of the irrigated land 2,660 acres were rented for an average of $21.60 per acre, while the rest was cultivated by the city. The most important crops raised were as follows:

	Acres.		Acres.
Irrigated meadows	2,550	Oats	1,700
Turnips	641	Beans	156
Mustard	108	Peas	125
Wheat	1,020	Red Beets	1,000
Rye	2,609	Carrots	126
Barley	353	Potatoes	380

In addition, willows, fruit trees, vegetables and other crops were grown. Upon the farms there were maintained 344 horses, 801 oxen and 159 cows. The expenses of maintaining the irrigation farms, including taxes of $25,000, all labor, and materials used upon the farms, repairs, etc., were

*Abstract from "Verwaltungs-Bericht des Magistrats zu Berlin. 1898-9, No. 40.—Kanalisationswerke und Rieselfelder."
†220 Broadway, New York city.

and the gross income from the sale of ... including an increase of $15,000 in the ... stock on hand, amounted to $601,000. ... farms yielded a net profit to the city ... The general expenses of the central ... tion, amounting to $63,000 per annum ... whole system), are not included in this ... nor are the sums spent for the pur... property, nor interest and sinking fund ... amounting to $740,000 for the whole ...

... of works to date is approximately $25,-... or $14.50 for each inhabitant. Of this, in ... numbers, the sewers cost $11,000,000, the ... stations, including land, $2,000,000; and ... mains which carry the sewage from the ... stations to the irrigation fields, $2,800,-... making a total cost to the disposal areas of ... The disposal areas have cost to date ... $9,800,000, of which more than half ($5,-... has been paid for land, only part of which ... as yet prepared. For the preparation of ... $2,740,000 have been spent for grading, ... for drainage, and some $700,000 for other ... buildings, etc.

Since the irrigation fields were first put in operation in 1884, the receipts have exceeded all expenses connected with their operation by about $380,000, but this statement does not include the cost of pumping, nor the interest and sinking fund payments.

The total permanent population upon the irrigation farms was 3,238, and there were 50 deaths, giving a death rate of 15.4 per 1,000. The number of deaths was nine greater than in the previous year, the excess being principally due to scarlet fever among the children. Not a single case of typhoid fever was reported upon the farms.

All of the reductions from metric to English equivalents have been made with a slide rule, and are approximate only.

THE MOTOR WAGON FOR HEAVY DUTY.*

By Arthur Herschmann.†

Taking up the different propelling agencies for motor wagons for heavy duty, we find that steam was employed as early as 1820, and that steam wagons were built by Ericsson and Tangyes in England, and even by James Watt, it is said. With the low steam pressures then available, poor roads and difficulties with unreliable material and workmanship, it is not surprising that the matter was allowed to drop. The next experiments were in the line of oil engines, followed by electric vehicles, compressed air, carbonic acid and the revived steam carriage.

Naturally, in this country, leading the world in electrical subjects, expectations were greatest with electric vehicles. The electric equipment renders a vehicle clean and easy to operate. These vehicles can be made to answer the requirements of running on smooth city roads. The suitable commutation of battery cells provided in these vehicles, effected through interconnection of contacts on the "controller," affords, together with the series and multiple arrangement of the motor, some flexibility in the power and speed conditions of the machine. There are, however, inherent disadvantages to the use of batteries, which grow prohibitive in a motor wagon intended to carry heavy weights over a long distance. It is common experience that on rough roads the punishment is more than the batteries can stand, and where we have a case of heavy loads to be carried, necessitating the use of steel tires, we can well say that at this phase of the evolution the battery makes the electric truck an impossibility. It would lead too far to enter minutely into the matter of cost of operating electric wagons, but it may be stated that the best traction cell has only a capacity of about seven watts per pound of its weight, and with this as a basis one can soon calculate how much dead weight a wagon would have to carry to propel a big load over a long distance with one charge. The "maintainance" of batteries, apart from the actual cost of charging, is seldom spoken of, though it is perhaps the most serious item.

Next to the electric wagon, we saw the compressed air truck, or, better still, heard about it. Now, while it cannot be denied that compressed air would make an ideal motive power, we have still to look for a complete revolution in the construction of light storage tanks to render this power available for trucks, granting that other disadvantages inherent to the use of compressed air can be practically overcome. Weight for weight, stored electricity lends itself more readily to the propulsion of wagons, since it will, as it were, "keep pressure" until it becomes well nigh exhausted, while the air pressure falls gradually as the air is drawn from the storage tanks. The tank weight per cubic foot of air is about 85 lbs; the air itself weighs 11 lbs, and at 2,000 lbs. per sq. in. represents 0.27 HP. hours. To heat the air considerable weight has to be carried.

Carbonic acid has also been proposed for the operation of wagons, but it suffers in common with compressed air, and, moreover, the raw material to be compressed is by no means cheap. It has also been proposed to compress illuminating gas, and use it for the propulsion of gas motor wagons. While the radius of the operating district for such a vehicle would be evidently greater than with the other storage systems, seeing that about 18 cu. ft. of gas at normal pressure would already give 1 HP., whilst about as many cubic feet of air of 200 lbs. pressure, or of carbonic acid of a high pressure, are required. This system has, however, the disadvantage of seriously complicating the mechanism.

A great deal of experience has been gained with oil motor wagons, though chiefly in the line of light pleasure vehicles. As regards freight vehicles, however, no important results have been obtained with the use of explosive motors. A motor wagon, on account of its great weight and peculiarity of operation, must have an abundant supply of power; so great, in fact, as to puzzle the uninitiated observer. We find that a load which can be easily negotiated by one horse calls for a power equipment equal to about 14 HP. on the part of a motor wagon. A horse, when required to pull a heavy load out of a difficult position, will not only jerk and lift the shaft so as to bring the wheels out of a rut and get them on a level, but will momentarily exert power which has been, by means of a dynamometer, shown to be adequate to a performance of what we commonly call 14 HP. The "speed-changing device," which should as nearly as possible emulate the peculiarity of the horse's muscular system, is still the greatest problem with designers of oil wagons. An oil engine to run a motor wagon cannot well be designed to vary in speed, at least not in a wide range, and be satisfactory in other respects. Its construction necessitates its running at a constant speed, whilst the speed requirements of the wagon wheels, to which it is geared up, are ever changing. Clutch and shifting-gear wheels are, therefore, essential parts of every oil motor wagon, and their operation, on account of the impact of the moving masses, often gives rise to serious trouble. Non-reversible, an oil engine is by no means a flexible motor. It will not start under load, and when it is in running condition it is very dependent on an even influx of its explosive mixture, and is liable to come to a dead stop without warning when its capacity has been suddenly overtaxed. It need hardly be said that an oil vehicle is dependent on the weather, inasmuch as the action of the carburator is influenced by the atmosphere. The good behavior of large oil engines on heavy trucks after an extended period of running has not yet been satisfactorily proven, and the deterioration due to the pounding on the frame is a serious drawback. The general use and handling of large quantities of gasoline at this stage of evolution of the oil engine is by no means free from risk of explosion, and there is some danger of affecting perishable goods and foodstuffs by the odor, which would naturally permeate them.

Having thus described the difficulties with which the electric and oil wagons have to contend, we may devote ourselves to the steam wagon, with which, undoubtedly, important results have already been obtained. We have found the steam wagon superior to its competitors for the following reasons:

(1) It has the greatest load and mileage capacity, or, in other words, radius of action.

(2) Its operation is independent of charging stations, and supplies necessary for the operation of the wagon can be easily procured and taken aboard quickly.

The operating expenses in the case of an electric (or, in fact, of any power storage system) vehicle grow to be prohibitive as soon as a certain ton mileage capacity is exceeded, tending to keep such an electric wagon small in size.

In the case of an oil wagon such economic restrictions to the size do not exist, and the objections to an oil wagon of large capacity are more by virtue of difficulties in operation.

With steam the case is altogether different. The tendency is here to build a large wagon, since with a steam wagon the weight of the machinery to be carried does not grow even in an arithmetical ratio to the carrying capacity. One advantage found in the operation of a large steam wagon may not be apparent to the casual observer. In the case of the horse-drawn wagon one has to discriminate in loading it with goods which are to be delivered only on the exact route covered by the wagon, seeing that the daily carrying capacity of a horse is limited, while in the case of a large steam wagon this would be less important, since, as will be shown later, the percentage of operating expense due to the actual cost of propulsion proper is infinitely smaller than in the case of traction with animal power.

Construction.—As regards the construction of steam propelled wagons, we find that in spite of the fact that steam equipment has been known for many generations, and wagon building has been going on for thousands of years, comparative success has only been obtained within the last few years. Messrs. Scotte and Serpollet De Dion, in France, were the first to revive the movement, but in the last few years more progress was made in England, in which country the best steam wagons, so far, have been produced. Easy riding wagons have been constructed for many years, and boilers, steam connections and engines do not give much trouble on rock bottom foundations, but when we attempt to locate engine and boiler on a wagon, which latter they have to drive without suffering from the shock of the locomotion on rough roads, new complications arise which are infinitely more important and troublesome than most people believe who have devoted themselves to the study of this subject. We find early attempts to effect this compromise in a steam vehicle built by the Ericssons in England in 1830, who placed a vertical engine on the rear of their vehicle and coupled it up with a long, springy connecting rod to the front wheels, which acted as drivers, thereby preventing excessive shock being transmitted from the wheels to the engine.

Wheels in themselves are far more important problems than is generally believed. My opinion is that at the present day no form of rubber tire will give satisfaction on a commercial wagon intended to carry a net load of, say, one ton or more. The rubber tire is not only expensive, but gives poor satisfaction under the combined action of great weight and speed. Attempts have been made to retain the desirable features of a rubber tire, protecting the latter with a tire shield of steel, dating back as far as the early 70s, but it would seem that such combinations are just as troublesome to maintain. Steel tires, if properly applied to stiff wooden wheels, have been proven to stand most severe work, and they afford the advantage of strengthening the wheels very considerably. It is my opinion that well constructed springs of ample proportions are alone the means to lessen the shock to which a wagon wheel is subjected. In the case of dished or cored wheels, which I consider to be best adapted for heavy work, a steel tire is indispensable, since it binds the wheel together and prevents the spokes from being torn out when striking an outer obstruction. There is considerable divergence of opinion as to whether a comparatively narrow tire or a wide tire should be used, whether the wheels should be small or large, and whether the front or hind wheels should be driven or steered. While it is a fact, even in the case of motor propelled vehicles, that the width of the tires should be smaller on hard roads and greater on soft roads (but not on sandy roads or in snow), I think that in the case of steam wagons the total width of the tires in inches should be at least twice the number of gross tons caried when small wagons are concerned, say, of a capacity of two tons of net load; this coefficient of two, to decrease in the case of very heavy wagons to one, and even under.

The reasons why small driving wheels seem to be exclusively used on motor wagons are mostly that it is difficult to design large wheels which will stand such severe strains as motor wagon wheels are subjected to. In this case the spokes of the wheel not only support the load, as in a horse-drawn vehicle, but they are more or less affected by the action of the driving power, and, moreover, there is also a tendency to twist them. With the ideal wagon wheel the power should be applied directly where the wheel touches the ground. In reality we drive onto a spur wheel, or chain wheel, concentric with the wheel, but, of course, of a smaller diameter, and such an arrangement makes it desirable that the wheel should also be small. Another reason making small wheels desirable lies in the requirements of the wagon and the working of a high-speed motor. In other respects it seems to me that a large driving wheel, say, of 4-ft. diameter, will answer much better than a 3-ft. wheel, such as has been almost exclusively applied to steam wagons. I consider that not only will a 4-ft. wheel allow of a more powerful starting torque, but it will also save the driving gear, seeing that it does not sink in as deep as a small wheel when it passes over a depression in the road.

The argument presented by advocates of the "front driving" system is that the wagon will steer a straighter course when the wheel strikes an obstruction, for the reason that the front wheels, in striking, tend to run over the obstruction, instead of being forced aside. I have seen such wagons steered behind and in front, and my opinion is that any advantage of front driving is more than outbalanced by the disadvantages introduced in connection with awkward location of the machinery. One of the early steam wagons was driven by all four wheels, and if such driving could be practically effected I think it would prove an excellent feature of a wagon. There are, roughly speaking, two steering systems used—steering with a fifth wheel, and, secondly, steering with pivoted axle ends. It would seem that the fifth-wheel steering arrangement is more adapted for heavy work, leaving the wagon axle unbroken. In reality this system cannot be as satisfactorily applied as steering with pivoted axle ends. To effect the steering of heavy wagons spur gearing of suitable purchase has to be used, or a worm and worm wheel device. The latter seems to answer in one of the best designed wagons, but I do not consider it as desirable as steering by means of spur gearing, since it locks the gear, and besides causes a severer strain on the wagon in case the front wheels strike an obstruction. In rounding

*Condensed from a paper read at the Cincinnati meeting of the American Society of Mechanical Engineers.

†Mechanical Engineer Adams Express Co., New York city.

a curve the inner wheels necessarily describe a smaller circle than the outer wheels. To make this practicable the steering device has to be correctly designed, and the two driving wheels have either to be driven by independent motors or have to be linked together by means of a compensating gear, or, as it is often called, "Jack-in-the-box." It will be found that in a heavy wagon, particularly one using dished wheels, this driving and the arrangement of the compensating gear are rather troublesome, and that there is still great scope for improvement in this connection. The transmission gear, forming the link between the rear wheels and the engine, which is almost invariably in front of the driving wheels, I think, can only be reliably effected by means of accurate spur wheels, immersed in an oil bath. With a steam wagon it is not necessary to use any kind of a clutch while running, seeing that the steam engine is a very flexible prime mover. Nevertheless, I think that a speed-reduction gear, which can be best provided by means of two sets of spur wheels of varying diameter, one set stationary, the other movable axially on a square shaft, forms a desirable adjunct to the mechanism, to be shifted when the wagon is at rest, so as to increase its traction power and enable it to negotiate any special hill or extricate the wagon from a bad position. We cannot deny that for many years to come greasy and hilly roads or deep snow will be the greatest difficulties to contend with. I attempted on a damp day to take a load of four tons up an incline of about 1 to 20, covered with Belgian blocks, and there was trouble with the drivers racing. The engine was geared 1 to 14, and the wheels were of 3-ft. diameter; in my opinion, large and heavier driving wheels and a much lower gear would have taken the wagon up. With the slightest turn of the valve, the engine, without difficulty, started and on account of the poor adhesion and the light machinery ran away before the inertia of the heavy wagon was overcome.

The next question we have to consider is the boiler and engine. Among the steam wagons built so far one can notice a great variety of boiler designs. The desiderata of a suitable boiler for a motor wagon are that it should be of the greatest safety, of small proportion, quick steaming and economical. In addition, it should be of the simplest possible construction and free from joints likely to work loose by jarring on the road. Pipe boilers, while perhaps a little safer than shell boilers, carrying little water, are, for the same reason, undesirable for the varying demands made of a wagon boiler. There are other objections to small caliber pipes; they are necessarily exposed to intense heat and liable to burn, and without a large dry tank they will make wet steam. A shell boiler, on the other hand, can be made of ample proportions, and, if well constructed and watched during its use, should give no apprehensions as to its safety. The water level can be more evenly maintained, and this is a point of some importance. I consider a superheating device an all-round advantage, provided it is correctly applied to the boiler.

In addition to the engine feed pump, there should always be a second steam driven pump instead of an injector, which latter, when of small proportions, has not yet been made to give satisfaction on a wagon.

The firing of a wagon boiler can be most easily effected by means of an oil burner, and with a steam governed burner the firing will automatically respond to the requirements. However, in addition to the inherent disadvantages of using oil, it is difficult to maintain the burner in good trim during all kinds of weather, and at this stage of perfection oil burners will "roar" and occasionally give trouble and make smoke. For the latter reasons coal and coke are preferable, being besides cheaper in use. Solid fuel can be conveniently stored away around the boiler, which latter is generally fixed in front of the wagon, and if thus located the stored fuel acts as a compressible safeguard to the boiler in case of a head collision. In using a shell boiler it is found convenient to fire through the boiler top, a system originally introduced into steam wagon practice with the De Dion boiler.

The difficulties with which one has to contend in the use of steam wagons are that they will ocasionally show a little steam, and during a sharp frost it will be found difficult to prevent a pipe from being frozen up. "Blowing off" will be found annoying, but this nuisance is largely caused by neglect of the driver and is suppressible.

However, these are difficulties which will be overcome in time; using a condenser there will be practically no visible exhaust in all weathers.

Condensers, however, are by no means desirable constituents of a motor wagon, and I should rather put up with an occasional cloud of steam than with a permanent shower bath due to leaky pipes and the difficulties in running a condenser. It can be well said that difficulties in connection with smoke have already been overcome.

The engine so far used is in almost every case a compound. If of vertical design it can be located under the driver's seat; while if of horizontal type it can be suspended from the body. In all cases a light and well designed quick revolution engine will answer the purpose if it is fitted with a reversing gear and means to admit high pressure steam to the low-pressure cylinder. The cylinder ratio should be larger than with stationary practice, seeing that the pressure used is higher, and that a large, low pressure cylinder means a powerful starting moment under live steam, and especial care has to be taken to connect the engine to the frame in an efficient manner. A flywheel is sometimes fitted and then used as a brake wheel, but I deem it unnecessary. As regards the size of the engine, I refer to tables appended.

Generally it can be observed that most of the wagons constructed are by far too light to stand the severe strain of their work. The cost of actual propulsion per gross ton is by no means as important an item as, for instance, in an electric vehicle, and one can, therefore, well afford to provide amply for a durable construction. A heavy wagon is just as easy to bring to a standstill as a light wagon—in fact, easier—since it may be fitted with quicker acting brakes, which, on account of their severe action, could not be fitted to a lighter construction.

The idea seems to prevail among some builders of steam wagons abroad that the driver should also effect repairs of the machinery, and that he should adjust the latter to suit himself. I rather think that this theory is against the economical exploitation of such wagons, more particularly if they are used in numbers. In the latter case a concern would probably house a number of wagons in a shed at a distance from their center of work which would be too great to stable horses there. Such a shed would have facilities for firing up, taking aboard of hot water and fuel, dropping grates, cleaning and maintaining, which operations could go on partly from below and without necessarily interfering with the handling of merchandise.

There would be a foreman capable of adjusting the machinery, or of replacing defective parts, and the driver would merely have to be competent to operate the controlling organs and to take care of his boiler. Radical improvements in the storage of electricity or of compressed gases, or relating to explosive engines may yet put the steam wagon in the background; but judging from accomplished facts it is so far the most successful wagon for the economical transportation of heavy loads.

I believe that if the motor wagon is given an unobstructed field and "fair play" it will hold its own and oust the horse-drawn truck in short order. The change must come, and with perhaps the exception of the harness-maker everybody will benefit by it. The main trouble seems that educated engineers have so far had little encouragement given them to develop the motor wagon, and that the confused efforts of amateurs and stock-jobbers have drawn the attention of almost everybody to their work, except that of the transportation community, who had no accurate data before them to judge of the practicability of the motor wagon.

BOOK REVIEWS.

A PRACTICAL MANUAL OF THE SLIDE-RULE.—By Charles N. Pickworth, Wh. Sc. Sixth edition. Manchester, England: Emmott & Co., Ltd. New York: D. Van Nostrand Co. Paper; 7¼ × 5 ins.; pp. 87; illustrated. 80 cts.

This little book, as its title indicates, is a manual describing the mechanical and mathematical principles of the slide-rule, and giving full and easily understood rules for its use. The form of slide-rule here discussed is the generally accepted Mannheim, or Gravet, type; though other forms are also described. As the author well says, a grasp of the simple fundamental principles underlying its operation, and a little patient practice, are all that are necessary to acquire facility in the use of this useful engineering tool.

U. S. COAST AND GEODETIC SURVEY.—Report of the Superintendent Showing the Progress of the Work from July 1, 1897, to June 30, 1898. Washington, D. C. Cloth; 11¾ × 9 ins.; pp. 489; maps and illustrations.

In addition to the scientific and technical results of the work of the year this report contains other matter of more general interest in its appendices. In them we have the report of the Stuttgart meeting of the International Geodetic Association in 1898. The determination of time, longitude, latitude and aximuth is explained at length, with a full description of methods and instruments employed. This is followed by a very complete plane-table manual; describing the instruments and their adjustments; use in field work; given tables useful in this connection; noting office work, etc. As a supplement to this manual various sheets of topographical symbols are given.

THE TRACKMAN'S HELPER.—A Book of Instruction for Track Foremen. By J. Kindelan. Revised by F. A. Smith, F. R. Coates and Jerry Sullivan. Cloth; 5¼ × 7½ ins.; pp. 334; illustrated. Price, $1.50.

This book was originally written by the late Mr. Kindelan, when a roadmaster on the C., M. & St. P. Ry., for the instruction of trackmen or section men in the details of their work, and to fit them for promotion as foremen. The general style of the original has been retained in the new edition, but the information has been brought up to date in many respects. The first two chapters deal with the laying of new track, followed by chapters on the various items of maintenance work to be looked after at different seasons of the year. Curves, frogs and switches, tools and other subjects are dealt with, and are followed by general instructions as to the watching and maintenance work of the track. The book is clearly printed, but most of the cuts are crude and are badly printed.

CONVERSION TABLES OF WEIGHTS AND MEASURES AND FOREIGN MONEYS.—Prepared by the Philadelphia Commercial Museum, 233 [illegible] St., Philadelphia. Paper; oblong; 8½ × 4 ins.; [illegible] pp. 82.

For convenience in converting money, weights and measures used in foreign countries into those of the United States, or vice versa, the Museum has issued a manual that has some novel features. The weights and measures of foreign countries are given alphabetically, with the place and the U. S. equivalents. Equivalents of measures of length, surface, capacity and weight are given from 1 to 10, both in the American and the metric units; thus 7 millimeters = .27559 ins., and 7 ins. = 177.80 millimeters, etc. The conversion tables for [illegible] are arranged in a similar way for both conversions and include English, German and French money and [illegible] United States. It is a convenient system for [illegible] here find, by simple inspection that, for [illegible] centimes = $0.00579, and 61 centimes = $[illegible] 3 pfennigs = $0.00714 and 61 pfennigs = $[illegible].

SULLIVAN'S NEW HYDRAULICS.—Consisting of New Hydraulic Formulas and the Rational Law of Variation of Coefficients. Flow and Resistance in Pipes, Canals, Flumes, Sewers, Pipes, Fire Hose, Hydraulic Gradients, Power Mains, Nozzles, Reducers, etc., with Extensive Tables and Data of Cost of Pipes and Trenching and Pipe Line Construction. By Marvin E. Sullivan, LL.B., Hydraulic Engineer. Denver: Mining Reporter Press. 1900. Cloth; 7¾ × 5½ ins.; pp. 300; $5.00.

The author of this work points out the lack of agreement in the results obtained by using the various hydraulic formulas deduced by the several experimenters, and then says that this fault in the formulas is due to the failure of the hydraulicians to discover the rational law of the variation of the coefficient. This fault the author endeavors to correct by first discussing the present available data, and then deducing new formulas, adapted to the conditions as he sees them. Mr. Sullivan also suggests important changes in the methods of measuring discharges over weirs and through orifices; and he has made a long series of experiments of the law of resistance in nozzles and convergent pipes, such as are employed in hydraulic mining. His new formulas are very fully worked out and discussed; but for them the engineer must be referred to the work itself, as space available forbids any intelligent abstract. The appendices give considerable practical information, chiefly compiled from the experiments and experiences of other engineers. They relate to the cost of work, dimensions of pipe, methods of work, and general water-works data.

ANNUAL MEETING OF THE AMERICAN WATER-WORKS ASSOCIATION.

The twentieth annual meeting of the American Water-Works Association was held at Richmond, Va., May 15 to 18, inclusive. Owing to the adoption at the opening session of a recommendation by the executive committee requesting the technical journals not to report the discussions on the papers read before the association at this and future meetings, our report is necessarily curtailed. This resolution was rescinded when the meeting was about half over, making it possible to report the discussion for the last half of the meeting.

After the usual addresses of welcome the executive committee reported the recommendation just recorded, together with one establishing $3 as the price of the annual report to non-members. Both of these were adopted. The secretary and treasurer reported that during the past year six active and two associate members had joined the association, and ten active and two associate members had been lost from the membership roll, making a net loss of four during the year. There were at the opening of the convention, 2 honorary, 284 active and 68 associate members, or 354 in all. The cash balance in the treasury was about $9 less than a year ago, or $407, besides which the association owns, as it did a year ago, $1,000 of U. S. bonds.

"Reminiscences."

By Maj. E. T. D. Myers, of Richmond, Va.

Mr. Myers was employed as engineer on the construction of the Washington Aqueduct from about 1853 until the outbreak of the Civil War, holding at the latter date the office of principal assistant engineer. Among other interesting features of this work he described a lining of 3-in wooden staves placed in the 48-in. cast-iron arched Rock Creek viaduct, to prevent freezing. This was subsequently removed on account of leaks, which immediately stopped. The paper closed with a quotation from Ruskin, to the effect that some workers place work first and fee second and others the reverse, the former class having the lord and the latter the devil for their master.

"Supplying Water from Deep Wells by Compressed Air."

By C. D. Wiles, Delaware, O.

This paper described the air lift system in general and its application to the wells at Delaware. The system has been most successful on slightly flowing wells, or at least on those where the water rose within 25 ft. of the surface. At Delaware a well with a natural yield of 45 gallons per minute gives 500 gallons under compressed air. At Indianapolis a total of 13,000,000 gallons a day is

air lifts. An inquiry failed to bring out from any one in attendance the duty obtained by the air lift.

"A Brief History of the Water Supply of Rockford, Ill."

By W. M. Kimball, Rockford, Ill.

The water supply of Rockford was from an impounding reservoir on a stream, into which a number of wells were subsequently built by the city, which supplied the works. Later a 50 x 38-ft. well was put down near the water from which proved to be more polluted than that from the river. Deep wells were then tried, and in 1893 the air lift was applied. About 1896 a contract was made with Mr. D. W. Mead, now of Chicago, to develop an additional supply by sinking a shaft and connecting it with the old deep wells and with new ones, and to furnish a centrifugal pumping plant to lift the well water from the shaft. These highly interesting improvements were described at length in Engineering News of July 13, 1899, from information supplied by Mr. Mead.

"Artesian Water Supply of the City of Madison, Wis."

By John B. Heim, of Madison, Wis.

This paper comprised a historical description of the Madison wells, of which a number have been sunk from time to time, 6 to 10 ins. in diameter and mostly about 750 ft. deep. A remarkably pure water has been secured. The earlier wells were too close together, then were sunk parallel with instead of at right angles to the underground flow. Latterly the geological conditions were observed in sinking the wells, with much better yields. The introduction of meters has postponed the necessity for additional wells.

"A Break in a 36-in. Water Main."

By A. A. Tucker, Memphis, Tenn.

On Feb. 16, at 5.35 a. m., a break occurred in a 36-in. force main at Memphis. The thermometer stood at about + 6° F. at the time. No explanation of the break could be found, except water hammer, but neither the pressure gage nor any other facts proved that to be the cause. The supply was speedily sent through a 20-in. main, and by 1 a. m. the next day, or in less than 20 hours, the break had been repaired by means of a sleeve and the main was again in service.

"Repairing a 36-in. Submarine Water Main."

By D. W. French, Hoboken, N. J.

In 1898 the Hackensack Water Co., of Hoboken, put a new 36-in. main in service, thus adding a third force main connecting its pumps and reservoirs, some 14 miles apart. The two older mains were 24 and 20 ins. in diameter, respectively. The three mains are cross-connected. The new main did not extend the full 14 miles. In August, 1898, this new main broke at a river crossing in 11 ft. of water (low tide). Pending repairs, 300 ft. of pipe were laid to by-pass the delivery of the broken main from the pump side of the break into the 20 and 24-in. mains, which, prior to the connection, were carrying about 9,500,000 gallons a day. In this way the carrying capacity of the two mains was increased by 3,150,000 gallons, or about one-third. The pressure was about 120 lbs. per sq. in. The break was repaired by disconnecting (with dynamite) the river crossing at each end and lifting out first one and then the other section by the aid of capped pile bents at the center of each pipe length and a pile driver for power. The sections were lifted 3 ft. above the water surface.

"Water-Works Records for Small Cities."

By R. D. Wirt, of Independence, Mo.

The form recommended was simply a book made up of 8 x 16-in. sheets of decimal cross-section paper, on which streets and house lots could be laid off with ease and pipe lines, hydrants, valves and other features indicated. The book should be indexed by streets or street intersections. This was a volunteer paper.

"Physical and Bacteriological Characteristics of James River Water at Richmond, Va., with Special Reference to Clarification Methods."

By Dr. E. C. Levy, of Richmond, Va.

The James River has a drainage area of about 5,000,000 acres, the upper portion of which has a retentive soil, slow run-off and yields a pretty clear water, high in carbonates of calcium and magnesium. The lower drainage area is clayey and has a much quicker run-off. The clay particles give the water a very reddish tinge during high water. The particles are very minute, having a diameter of only 1-120,000-in. In 1899 the water was classed as clear for 85 days, slightly turbid on 50 days, very turbid on 168 days and muddy on 62 days. When a freshet follows a dry spell the bacteria are high, as well as the turbidity, but at other times there seems to be no relation between the bacterial and physical conditions of the water. Generally the bacteria are very few, running 100 per cu. cm. or less day after day and rarely exceeding 200. Last summer experiments on sedimentation were made by Dr. J. W. Mallett, Chemist, and Dr. Levy, a 20,000,000-gallon compartment of a reservoir being used for the purpose. At a depth of 4 ft. from the surface the following results were observed for five-day periods:

Days.	Percentage reduction. Sediment.	Bacteria.
5	23	14
10	38	62
15	58	79.5
20	68	80

From these figures it was concluded that sedimentation alone would not sufficiently reduce the turbidity. Slow sand filtration was held to be impracticable, on account of the minuteness of the particles of suspended matter. It is deemed advisable to build as large a storage or subsiding reservoir as seems feasible and see what it will do for the water. If this proves insufficient it may be supplemented by coagulation at times; if there is still trouble a mechanical filtration plant may be added.

"Iron as a Coagulant in Connection with Mechanical Filtration."

By Dow R. Gwinn, Quincy, Ill.

This coagulant has been used for some two years at Quincy. The supply is pumped from the Mississippi River to a 350,000-gallon covered settling reservoir, the capacity being about equal to two hours' pumping. The coagulant is admitted to the water on its way to the settling reservoir, and lime water is added to the water in the reservoir. From the latter the water goes to the mechanical filtration plant, after which it is sent to the consumers.

The raw water carries a large amount of carbonate of lime at times of low flow, and at the same periods it is high in organic matter. After rains the suspended matter sometimes exceeds 1,200 parts per 1,000,000. At times the water is highly colored by vegetable matter.

About two years ago Mr. W. M. Jewell, of Chicago (of the O. H. Jewell Filter Co.—Ed.), with the assistance of Mr. Gwinn, began some experiments on the use of iron as a substitute for alumina at Quincy. The present apparatus for producing the iron is crude, material at hand being used as far as possible. It consists of a kettle in which sulphur is burned, the fumes being condensed in a tank with a stream of water, forming a sulphurous acid solution. This solution is circulated through a second tank containing scrap iron, wherein the acid eats or dissolves the iron. * * * The iron solution then flows into a third tank, where it is settled; from this tank the solution is drawn into the suction of the raw water pump.

The lime water mentioned above precipitates ferrous hydrate of iron. It also reduces the hardness of the water, and it is claimed that being heavier than alumina it has a greater value as a subsiding agent. The estimated cost per 1,000,000 gallons of water treated for the sulphur and lime used at the worst stages of the river is as follows:

½ grain sulphur per gallon, or 480	lbs., at 2.13 cts.				$1.02
4 " lime	"	"	7.2 bu.	" 18 "	1.30
⅜ " scp. iron	"	"	54.0 lbs.	" 1-5 "	.11
Incidentals, etc., 10% additional					.24
					$2.67

Mr. Gwinn estimated that 715 lbs. of sulphate of alumina, or about 5 grains per gallon, at 1.4 cts. per lb., would have been required to do the same work, or $10 per 1,000,000 gallons.

Samples collected March 12, 1900, showed 1,248 parts per 1,000,000 total residue on evaporation in the raw water and 109 in the filtered water, a reduction of 91.3%. The oxygen consumed was reduced from 24 to 6 parts, or 75%, and the albuminoid ammonia from 1.088 to 0.128, or 88.2%. The nitrates were reduced from 0.480 to 0.400, or 17%. These analyses were made by Prof. A. W. Palmer, of the University of Illinois. Recent analyses showed a total hardness in the raw water of 4.2 grains per gallon and of 2.8 in the filtered water, a reduction of 33%. A switch engine at Quincy has been run 27,000 miles in nine months, using this water, without cleaning, and found to be as free from scale at the finish as at the start.

"Modified English System of Filtration."

By P. A. Maignen, of Philadelphia.

This was a volunteer paper. The author suggested filter beds 4 ft. deep, built over reservoirs and provided with a thin surface layer of asbestos (in accordance with a plan Mr. Maignen is endeavoring to introduce in this country.—Ed.). He would divide the filters into compartments 16 x 100 ft., to facilitate cleaning. In place of sedimentation he would use a rapid rate of filtration, say 50,000,000 gallons per acre, supplemented by coagulation, if necessary.

"The Norfolk, Va., Filter Plant."

By Edmund B. Weston, of Providence.

Portions of this paper have been combined with matter from other sources to form a comprehensive article on the development of water purification at Norfolk, given elsewhere in this issue. Mr. Weston's paper was devoted chiefly to the mechanical filters recently built at Norfolk by the New York Filter Manufacturing Co., after plans by Mr. Weston; and also to a general description of mechanical filtration as practiced by the company named. There was practicaly no discussion on the three papers relating to filtration, which was partly due to lack of time.

"Electrolysis."

By D. H. Maury, of Peoria, Ill.

After giving a lucid explanation of the nature of electrolytic action on underground pipes, Mr. Maury reviewed his experience with it on the Peoria water-works, including a detailed investigation to show whether or not two stand-pipes connected with the works were affected in this way. He was confident they were. One of these stand-pipes failed in 1894 (Eng. News, April 5, 12 and 26, May 10 and Oct. 4, 1894). Mr. Maury also described some experiments made on lines of cast-iron pipe laid above ground temporarily. He said, in conclusion, that the only way to prevent electrolysis is to keep the electric currents above ground and recommended the double trolley system as the best way to do that. In answer to a query, he said that in one case the estimated cost of changing from the single to the double trolley system was $1,600 per mile, but local conditions tended to a higher cost than usual. This paper, as well as the one preceding and the one following, was illustrated by lantern slides.

A Committee on Electrolysis Appointed.

On motion of Mr. Maury the chair appointed Messrs. Maury, G. H. Benzenberg and F. Waldo Smith a Committee on Electrolysis. Mr. Maury urged the need of such a committee in view of the character of the recommendations of the committee which had the subject under consideration a few years ago. The old committee acted in accordance with the best ideas of the day. The new committee will submit a report for inclusion in this year's proceedings, to be acted on next year.

"Water-Works Management — Professional and Councilmanic."

By John C. Trautwine, Jr., of Philadelphia.

This was a forcible paper, contrasting the two systems indicated by the title, as exemplified by Philadelphia and Milwaukee. The new charter of Philadelphia, which went into effect in 1887, provided for the professional plan, but, as everyone knows, quite the contrary has prevailed, for the most part, thanks to the city council and its control of appropriations. Two very effective diagrams were shown to illustrate the reduction in consumption with the increase in the use of meters at Milwaukee and the steady and rapid increase in consumption at Philadelphia, which has never had as much as 1% of its taps metered. The contrast is presented in the accompanying diagram, which combines the Philadelphia and Milwaukee curves and also gives the names of the officials in charge of the two water departments, Mr. Geo. H. Benzenberg being in charge at Milwaukee for the whole period and having quite a free hand, while at Philadelphia there were numerous officials in charge, all of whom were more or less hampered by councilmanic interference or starvation, through failure to make appropriations; Mr. Trautwine, particularly, having scarcely a cent for new construction during his three years of service. The only man who seemed to be able to check waste in Philadelphia was Colonel Ludlow. Speaking of the results obtained by Colonel Ludlow and himself, Mr. Trautwine said:

> In contrasting the history of the last three years, shown in the Philadelphia diagram, with Colonel Ludlow's fine record, the writer may be permitted, in his own defense, to observe that as Chief of the Bureau of Water he was merely a subordinate official in an administration which got from councils no favors that could possibly be denied, whereas Colonel Ludlow, as Chief Engineer of the Water Department, although elected by councils, was a responsible and independent officer, capable of carrying on war even against his creators when the public interests demanded it. That he did so appears not only from the shortness of his term of office, but also from the closing words of his letter transmitting to councils his final report, that for 1885:
>
> "I regret that the termination of my official connection with city affairs, and present departure for another field of duty, leave me without adequate time or opportunity to enhance the possible usefulness of this report by formulating therein certain detailed statements and discussions relating to the water service of the city additional to those which have heretofore been presented, but the apprehension of a duty in this respect partially unfulfilled is tempered by the consideration that my reports for the years 1883 and 1884 contain a large body of important data and recommendations, of which the greater part remain still unacted upon; and that if the conduct of affairs in the future shall proceed with the deliberateness which has marked the securing of urgently needed improvements in the past, so protracted a period will be required for their practical execution as to render superfluous any material additions thereto at the present time."
>
> That a change came over the councilmanic attitude toward the Chief Engineer upon Colonel Ludlow's retirement appears from the closing words of the first annual report of his successor, who sincerely thanked the chairman and members of the Water Committee of Councils "for their valuable assistance and advice * * * and for the very pleasant relations that existed between us during the past year."

"Some Hints for the Management of Municipal Water-Works."

By C. F. Ulrich, M. D., of Wheeling, W. Va.

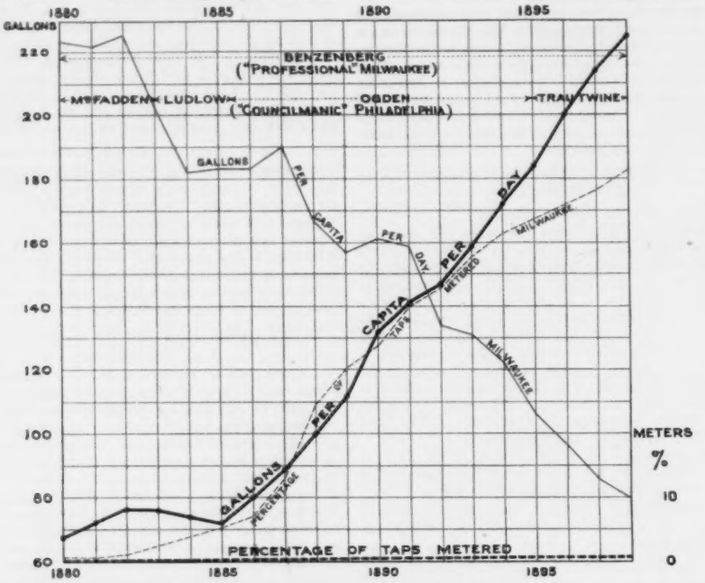
This paper showed the author to be in accordance with civil service ideas and in favor of business rather than political methods. At Wheeling, unfortunately, a new water board is appointed once in two years, after the municipal election. The board, by law, must be composed of two members of the political party in power and one member of the rival party. The members are placed under $30,000 bonds and they receive nominal salaries of $100 a year each. The author believes the commissioners should be well paid for their work.

"A Brief History and Description of the Richmond Water-Works."

By Chas. E. Bolling, of Richmond, Va.

A water supply was introduced at Richmond in 1830, water power pumps lifting water from the James River to a reservoir. These works have been extended from time

to time since then. During the last three years an expenditure of $23,000 for meters has reduced the water consumption and waste by 40% and saved an outlay of $270,000 for larger works. Some of the pumps still in place are 70 years old. One of the greatest difficulties



USE OF METERS AND WATER CONSUMPTION AT PHILADELPHIA AND MILWAUKEE.

encountered in operating the works is anchor ice at the intakes, which accumulates there just at a time when the pumpage is very high on account of the waste of water to prevent the freezing of services. At the close of this paper Mr. John C. Trautwine, Jr., suggested that the anchor ice might be prevented, as at Philadelphia, by carrying the warm condenser water to the intake. Mr. Bolling said this could be done when his steam pumps were running, and that he had been considering provisions for the use of steam whenever needed.

"A Review of a Recent Paper, 'He Who Runs May Read.'"

By F. A. W. Davis, of Indianapolis, Ind.

The paper reviewed was one presented at the last meeting of the association (see Eng. News, May 25, 1899, p. 338) by Mr. John W. Hill, on certain clauses in franchises. Mr. Davis concerned himself chiefly with Mr. Hill's interpretations of the meaning of the word "franchise," as employed in that part of the franchise of the Indianapolis Water Co. providing for the purchase of the works by the city. The clause in question states that in case of purchase nothing shall be paid for the franchise. Mr. Hill construed this to exclude any valuation based on the net earnings of the company (but stated that where a franchise contained no provision against including its value, then the net earnings ought to be taken into account.—Ed.). Mr. Davis believed that the property to be excluded under the meaning of the word franchise in the Indianapolis case should be only what the city actually granted the company originally, and that the city would be compelled to pay for the value of an established business. In the Kansas City case the U. S. Court compelled the city to pay the company a sum for the "going value," and an allowance of the same sort was made in the recent Dubuque arbitration, Mr. Hill being one of the arbitrators or witnesses in the latter case.

In discussing this paper Mr. Peter Milne said franchise valuations were questions of finance rather than engineering, and, therefore, should be left untouched by engineers. As to tangible property, he mentioned the valuable discussion of deterioration in the recent Los Angeles report, abstracted in Engineering News of May 4, 1899.

"Can Lead Services be Affected from Steam Mains Near Them?"

By T. N. Hooper, of Davenport, Ia.

Mr. Hooper had no doubts on this question. He had had a number of broken lead services near a steam main. The steam main was 21 ft. and the water main 13 ft. from the curb. The steam main was laid in pump logs, but the steam services were taken out through boxes filled with sawdust. There were leaks at these boxes, and the evidence showed that the ground and the water services were heated as a consequence. The lead services to houses on the same street out of range of the effects of the steam main did not break. The matter was fully investigated by the Raymond Lead Co., of Chicago, through Mr. Gustavus Johnson, who concluded that the lead was damaged by heat from the steam pipes. There is a trolly line in this street, but that apparently had nothing to do with the case, as shown by current tests and otherwise.

Report of Committee on Pipe Coatings.

Mr. M. R. Sherrerd read a report from Mr. F. W. Capellen, of Minneapolis, chairman of this committee. The report gave nothing new, except to continue and confirm the account of the Minneapolis tests presented before the association in 1898 (see Eng. News, June 23, 1898; see also May 17, 1900, "Asphalt Coatings for Water Pipes," for an extended review of the subject, giving the results of Mr. Capellen's latest investigations). On request of the committee it was discharged.

"A New Definition of Water."

By C. Monjeau, Middletown, O.

The author laid down some twenty propositions, by which he sought to establish the principles that water is a living individual, composed of many separate individuals; that the so-called ultimate atoms of hydrogen may be living cells; and, finally, that water must be to the personality of God what blood is to man: therefore water is the chief means of converse of man with his Maker; water naturally pure can minister to man's regal needs of body, mind and soul, but if its purity is neglected its ministry may be to man's death and worse. For further information Mr. Monjeau referred those interested to a book which is soon to be printed for sale at cost, and which he hopes will be placed in every home in the land. After the reading of this paper Mr. Monjeau, in response to a call for a report from the committee to memorial Congress and the President on stream pollution, reported progress, and offered a resolution for the appointment of a committee to wait on the President of the United States and urge the enactment of the so-called Bartholdi bill against stream pollution (H. R., No. 5). Mr. H. A. Keeler moved to lay the resolution on the table, on the ground that this bill was really a part of the St. Louis-Chicago controversy over the Chicago Drainage Canal, and that the association ought to keep clear of it. Mr. Geo. W. Fuller gave many other reasons for deferring action. The resolution was finally withdrawn.

Report of Special Committee on Mr. Monjeau's Pamphlet.

On the first day of the convention Mr. Allen Hazen brought to the attention of the association a pamphlet circulated last winter bearing upon its title page the following inscription: "Impending Dangers to Health and Life from Abuse of Water in North America. Abstract of a Report by a Committee Appointed by The American Water-Works Association to Memorialize the President and Congress for Laws Protecting Public Sources of Water Supply Pure for the People." Mr. Hazen read some extracts from the pamphlet and from editorials in the "Engineering Record" to show that the pamphlet was of such a character as to make its circulation by the association most ill-advised, and that the alleged abstract was never submitted to at least two of the committee from which it purported to emanate, namely, Prof. A. R. Leeds, Chairman, and Mr. L. A. Le Conte. Mr. Hazen then moved the appointment of a committee to learn whether the publication of the pamphlet was ever authorized by the association, and, if not, who was responsible for such action and what amendments to the constitution were necessary to prevent another occurrence of the sort. The motion having been carried, Mr. W. R. Hill, First Vice-President of the Association, who occupied the chair the first day of the meeting, in the absence of Mr. R. M. Clayton, President, appointed the following committee: Allen Hazen, John C. Trautwine, Jr., F. A. W. Davis, Harlow and Jos. A. Bond. At a subsequent [illegible] committee submitted the following report:

Your committee has had interviews with the [illegible] members of the Committee on Stream Protection [illegible]sent at this convention, and our chairman has laid before us letters from the other three members of the Committee on Stream Protection. From all of these members, including Mr. Monjeau, the secretary, your committee learns that Mr. Monjeau presented at the convention of the Association held in Columbus, O., in 1899, as an abstract of a report by the Committee on Stream Protection over his signature as secretary of that committee, a paper which he himself had prepared, but which had not been submitted to the chairman or to any other member of his committee, and which, nevertheless, was intended to be served as a memorial to the President and Congress.

At the Columbus convention, four members [illegible] Committee on Stream Protection being present, Colonel Gardner, a member of the committee, moved that the paper be printed in the proceedings, but his motion was not entertained.

It appears from the printed record of the Columbus convention that Mr. Heim afterward moved [illegible] 2,000 copies of the paper be printed for distribution, and this motion appears to have been carried.

In a preface to the paper in question, written by Mr. Monjeau and signed by him as secretary of the committee on Stream Protection, he announced that the abstract following was a portion of a book which was to be printed and published at cost, and called upon doctors, pastors and teachers to aid in the circulation of this book.

We find that Mr. Monjeau, before presenting his paper to the association as an abstract of a report by his committee, should have laid it before the chairman of his committee and secured the formal approval of that committee.

In view of the importance of stream protection to the public welfare, we recommend: (1) That the Committee on Stream Protection be requested to prosecute its labors with all proper dispatch and furnish to the association as early as practicable a report signed by each member of the committee and submitting a memorial for presentation to the President and Congress.

(2) That each member of the Committee on Stream Protection be advised of the action of the association on this report.

(3) That a special committee be appointed to draft amendments to the constitution providing for the appointment of a standing committee on publication, without whose approval no papers or reports shall be printed in the proceedings.

This report was adopted, with the exception of the third or final recommendation, but the end sought therein was obtained by another resolution passed in connection with the discussion on restricting the technical press, as noted below.

Restrictions on the Technical Press.

Mention was made at the beginning of this report of the adoption by the association of a report from the Executive Committee requesting the technical press to refrain from publishing the discussions on papers read at the convention. On motion of Mr. J. H. Decker, near the close of the second day of the convention, this restriction was removed. It appeared from the discussion on this subject that the proposition to restrict the technical press was due to the belief of some that the sale of the proceedings (stated to have numbered only three copies last year) would be increased thereby, and also to a desire to prevent the publication by a single paper of a practically full report of the discussions, taken from the notes of the official stenographer. On reconsideration a number of members expressed their appreciation of the valuable services rendered the association by the technical press in publishing prompt reports of the meetings. Some had no objection to having the discussions reported verbatim, but on its being explained that the one paper which pursues this course makes use of the official stenographer's notes before they have been revised by the various speakers, a motion made by Mr. H. A. Keeler was adopted to the effect that hereafter the official stenographer should not give out his notes until they had been revised by the participants in the discussions. At this juncture Mr. M. R. Sherrerd moved the appointment by the chair of a committee of three to report at the next meeting on all matters relating to publication. The motion was carried, and Messrs. Sherrerd, J. H. Decker and H. A. Keeler were appointed as that committee.

General Business.

During the convention 17 active and three associate members were elected. Mr. C. E. Bolling, Superintendent of the water-works of Richmond, Va., was elected as President for the ensuing year, receiving 35 votes against 17 for Mr. Edmund Mather, of Harrisburgh, Pa. Mr. Peter Milne, Bennett Building, New York city, was re-elected Secretary, having 37 votes to 27 for Mr. John C. Trautwine, Jr. Vice-Presidents were elected as follows: C. N. Priddy, Leadville, Colo.; Wm. Himrod, Erie, Pa.; T. N. Hooper, Davenport, Ia.; C. N. Campbell, Charlotte, N. C. (re-elected); W. H. Laing, Racine, Wis.

New York city was chosen as the place for the next meeting, receiving 38 votes to 24 for Detroit and 5 for Baltimore.

On Tuesday evening the Mayor, City Council and a committee of citizens of Richmond gave a reception to the members and guests of the association. This was followed by a complimentary concert on the roof garden of The Jefferson, the hotel in which the convention met. On Thursday evening there was a boat ride down the James River, and on Friday a visit was made to the pumping station and reservoirs of the Richmond water-works.

The usual exhibit of water-works appliances is noted in our Construction News supplement.

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